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ART. XIII.—*On the Evaporative Efficiency of Steam Boilers;* by WM. P. TROWBRIDGE, Professor of Dynamic Engineering in the Sheffield Scientific School.

Transfer of heat.—The quantity of water which a steam boiler apparatus will evaporate in a given time depends primarily upon the temperatures to which those parts of the plates of the boiler, known as heating surfaces, are exposed. In the furnace, the heating surface is exposed to the radiant heat of the incandescent fuel, and to the contact of the heated gases; and in the flues to the contact of the gaseous products of combustion alone. The temperature of the fuel, and the initial temperature of the gases, depend on the intensity of the combustion, or the quantity of fuel burned on each square foot of grate surface in a unit of time, and also on the kind of combustion which takes place: *perfect combustion*, in this connection, designating that in which no combustible gases or uncombined oxygen escape to the chimney. This condition is presumed to give rise to the highest possible temperatures in the residue of fuel, and in the escaping products.

The quantity of fuel burned, the constitution of the escaping gases, and the resulting temperatures, depend on the following conditions:

1. The quantity of air which passes through the furnace in a unit of time.

2. The amount of surface of the fuel with which this air comes in contact.

The quantity of heat transferred to the water within the boiler will then depend on the amount of heating surface

exposed to direct radiation, the amount of heating surface exposed to the contact of the gases, and the *laws* of absorption or *transfer of heat* under these conditions.

The quantity of air supplied to the furnace, in a unit of time, depends upon the chimney, or other apparatus for producing the draft, and the surface of contact of air and fuel; upon the kind of fuel, size of lumps, thickness of bed, etc. There are other conditions which influence the evaporative efficiency of boilers, when the total heat of combustion is to be compared with the quantity of heat transferred to the water; such as the losses from imperfect combustion, diffusion of heat, escape of heat through the chimney, etc., making an aggregate of losses which must be estimated.

The following general discussion of the problems involved is given, as suggesting a mode of investigation which may lead to more satisfactory experiments on the laws of transfer of heat.

Let Q represent the quantity of heat transferred to the water of the boiler in a unit of time, one hour for instance.

Q_1 the portion of this heat which is transferred by radiation in the furnace.

Q_2 that part which is transferred by contact of heated gases in the furnace.

Q_3 the part which is transferred by contact of heated gases in the flues.

Then $Q = Q_1 + Q_2 + Q_3$.

In this expression, the first member may be regarded as known, because it may be easily ascertained by experiment. Of the terms of the second member, Q_1 represents the quantity of heat transferred by radiation from the surface of the fuel.

According to the laws of Dulong and Petit, this quantity may be represented by

$$Q_1 = q \times G = C.\, a^{\theta}(a^{t}-1).\times G.$$

in which q represents the quantity of heat transferred by radiation from one square foot of grate surface in a unit of time, G the grate surface in square feet, C a constant, $a = 1{\cdot}0077$. θ represents the temperature of the absorbent body, or the water in the boiler (a constant which may be determined by observation), and t the difference between this temperature and the higher temperature of the incandescent fuel.

By the law of transfer of heat by contact of gases, given by Dulong and Petit, we shall have

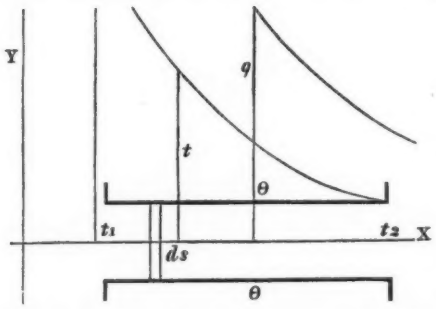
$$Q_2 = F. \times C.' t_1^{1{\cdot}233}.$$

F representing in square feet the furnace surface, $C' t_1^{1{\cdot}233}$ the quantity of heat transferred by contact of the gases in the furnace in a unit of time; in which t_1 represents the difference of temperature between the gases in the furnace, and the tem-

perature, θ, of the water in the boiler; this difference being constant for the whole furnace surface. It is presumed that the law of Dulong and Petit for *the cooling of bodies by contact of a cooler gas is also the law of heating by a hot gas;* the side on which the excess of temperature exists being a matter of indifference.

For the transfer of heat by contact in the flues, the application of the law renders it necessary to take into account the diminution of temperature, from the initial temperature t_1 to the temperature t_2, of the gases, as they leave the flues and pass into the chimney.

Let the combined flue surfaces be represented by a single cylindrical surface in the form of a tube, as in the figure below, and assume two coördinate axes, one in the axis of the tube and the other perpendicular to it; and let t_1 be the difference of temperature of the gases and the water outside of the tube, at the entrance, and t_2 the corresponding difference of temperature at the exit of the gases.



Let q represent the quantity of heat transferred in a unit of time (one hour) at any point of the tube from one unit (square foot) of surface. When a boiler is at work the temperature of the gases at any point, or of the plates in contact with the gases, may be regarded as constant, and it will not, therefore, be necessary to regard the conductivity of the plates; this being necessary only when the surfaces of the plates undergo a change of temperature, as in getting up steam.

If the heating surface represented by the surface of the tube be divided into elementary portions by planes perpendicular to the axis, the element of the surface between two planes may be represented by ds, and the quantity of heat transferred by contact through the element will be represented by $q\,ds$.

If we represent by c the specific heat of the gases, by W the weight of gas which passes the element ds, in a unit of time, (one hour), and by dt the element of time; it is evident that the cooling of the gas in the time dt will be $c\,W\,dt$, expressed in units of heat, and this quantity must be equivalent to that received or absorbed by the water, represented above by $q\,ds$: a relation expressed by the equation:

$$q\,ds = c\,W\,dt \qquad \text{from which} \qquad ds = \frac{c\,W\,dt}{q}.$$

Introducing now the law of Dulong and Petit, by substituting for q its equivalent $C'\,t^{1\cdot233}$, the expression becomes

$$ds = \frac{c\,W\,dt}{C'.\,t^{1\cdot233}} \qquad \text{or} \qquad \frac{ds}{c\,W} = \frac{t^{-1\cdot233}\,dt}{C'}.$$

Integrating between the limits t_1 and t_2 we obtain

$$-\frac{s}{c\,W} = \frac{t_1^{-\cdot233} - t_2^{-\cdot233}}{-\cdot233 \cdot C'}$$

from which the value of t_1 may be obtained,

$$t_1 = \left(\frac{c\,W\,t_2^{\cdot233}}{c\,W - \cdot233\,C'S.\,t_2^{\cdot233}}\right)^{\cdot\frac{1}{233}}.$$

In this expression S represents the whole heating surface of the boiler, or the surface of the tube, a known quantity; t_2 may be ascertained by observation with a common thermometer. But no accurate mode of ascertaining t_1 by observation has yet been found, and hence the necessity of this mode of determination.

In the second member of the equation the undetermined quantities are W and C′, the first representing the weight of gas which passes through the furnace in an hour, and the second the constant C′ of the formula of Dulong and Petit.

If W be taken on the assumption, *generally acquiesced in*, that in ordinary boilers the quantity of air which passes through the furnace is just double the quantity necessary for perfect combustion, and we assume for C′ the value given by Mr. Hopkins for carbonic acid gas, the value of t_1 is completely determined; and to find the initial temperature of the gases, it will be only necessary to observe, with the aid of a common thermometer, the temperature of the gases at their exit from the tube or boiler. Having found t_1, the quantity of heat transferred by contact of the gases, in the flues, to the water, will be represented by

$$c\,W(t_1 - t_2).$$

The value of Q then becomes

$$Q = C\,.\,a^{\theta}.\,(a^t - 1)\,.\,G + F\,.\,C'.\,t_1^{\,1\cdot233} + c\,W\,(t_1 - t_2).$$

in which all the terms become known, except the first term of the second member.

The value of the expression $G \times C.\,a^{\theta}\,(a^t - 1)$ being thus determined, the separate influence of the radiant heat of the furnace becomes known, and the value of t, the difference of the temperature between the *fuel and the water*, may, by the aid of Hopkins' value of C, be ascertained.

Resuming the expression $\frac{ds}{c\,W} = \frac{t^{-1\cdot2\,3\,3}dt}{C'}$, if we suppose the tube to be extended indefinitely and the gases to be forced through the tube by some extraneous pressure, the difference between the temperature of the gas within the tube and the water would ultimately become zero.

Integrating the above expression between the limits t_1 and t_0 we should obtain an expression by which the relations of t and S. and of q and S. become known. t, the difference of temperature at any point, will be $t=C''\frac{1}{S^{4\cdot3}}$ and $q=C'''\frac{1}{S^{5\cdot3}}$ equations which indicate the form of curve of temperatures along the axis of the tube, and also the form of curve of emissions of heat along the axis. It is evident that these curves approach the axis rapidly. The constants C'' and C''' involve both c W and the constants of the law of Dulong and Petit, and the curves may therefore be constructed by assuming these as before.

Unfortunately, however, it is not probable that either of these quantities can be assumed in the present state of knowledge of the action of chimneys, the combustion of fuel, and the phenomena of transfer of heat. It is certain that the assumption of twice the quantity of air necessary for combustion is not a universal law. And in regard to the constants of the formulas of Dulong and Petit, it can hardly be said that they have been completely determined or interpreted. The quantity of heat transferred by contact of a gas depends on the mode or rate at which the gas is supplied to, or removed from, the surface to be heated or cooled. This is the principal element in the problem. It seems evident that, according to the present state of knowledge of the *conductivity* of gases, heat must be transferred with excessive slowness, unless currents are established in order to bring fresh particles of gas in contact with the surface to be heated or cooled each instant.

By making use of an apparatus like the steam boiler it may be possible to determine these constants, as well as the quantity c W, for different dimensions of chimneys or force of draft, thickness of bed of fuel, etc. It would be necessary to make experiments under such conditions that some of the quantities could be eliminated, as, for instance, the initial temperature. If the same chimney be employed with the same kind of fuel, thickness of fuel on the grate, and under the same general conditions of barometer and thermometer, the initial temperatures must be the same, and, by properly varying the heating surface, different values of the final temperatures might be obtained and observed. The quantity of air used being measured, the

law of change of temperature, or of transfer of heat, might then be ascertained for the flues and for the furnace separately.

If the laws of Dulong and Petit be true for high temperatures, it is apparent that the influence of the furnace at high temperatures must preponderate. Under any circumstances, it seems impossible to find a *scientific* solution of the important problem of efficiency of boilers in the generation and transfer of heat, until these questions are solved.

The laws of Dulong and Petit have not been verified for high temperatures. At very low temperatures the quantity of heat transferred by contact of a gas and by radiation, according to these laws, will be nearly identical, and the higher the temperature the greater becomes the difference in the effects.

Common observation shows that to heat or cool a body rapidly by contact of a gas, the gas must be supplied and removed rapidly. It seems improbable, therefore, that there can be any general expression for the quantity of heat transferred in this manner which does not involve this idea in some other way *than by the constants which have been adopted.*

The mode of determining the initial temperatures of the furnace and gaseous products of combustion generally employed, up to the present time, has been to assume, from the partial experiments of Péclet and others, that half the heat of combustion is usually imparted to the gases, while half passes off as radiant heat, and then to estimate the temperatures on the further assumption that a definite known amount of air passes through the furnace for each pound of coal burned. From the nature and phenomena of combustion it can hardly be supposed that any such law as that assumed by Péclet can be universally true. The temperature of the residue of the solid combustible must depend on the special circumstances of combustion in each case, and especially on the law of radiation, at different temperatures.

If it were possible to observe accurately the temperatures of furnaces and flues, the solution of all these questions would be greatly simplified; and the discovery most needed to advance this branch of physical research is a thermometer for determining high temperatures. The only method available at present seems to be that of going back from a temperature which falls within the range of ordinary thermometers to the initial temperatures, by analysis. And the mode of investigation herein suggested is offered as one which apparently conforms to known or accepted laws, and does not require doubtful assumptions. Whether the laws of Dulong and Petit are true for all differences of temperature, and whether these laws may not be revised so as to involve directly the dynamic theory of heat, are questions which such investigation may help to solve.

The complete expression for the total heat of combustion of fuel in the boiler will be

$$E=Q+E_1$$
$$=Q_1+Q_2+Q_3+Q_4+Q_5$$

in which Q_4 represents the heat in the gases after they leave the flues represented by $c\,W\,(t_2-t_0)$, and Q_5 the losses from external radiation, incomplete combustion, etc., which can only be estimated.

ART. XIV.—*Description of two new Land Snails from the Coal-measures;* by F. H. BRADLEY.

IN the summer of 1869, I found that the concretionary limestone accompanying the underclay of coal No. 6 of the Wabash Valley section (see Illinois Rep., iv, 254), at Pettys's Ford of the Little Vermilion river, below Georgetown, Vermilion county, Illinois, contained numerous minute shells. (A small fragment of fish-bone is the only other fossil yet found in it.) A *Pupa* was readily recognized, and, from its outline alone, referred to *P. vetusta* Dawson. The other of the two species was doubtfully referred to *Zonites*. Later, in cleaning out the mouths of some individuals, a distinct tooth was found on the columella of the *Pupa*, and a broad lamellar extension of the columella of the so-called *Zonites*. The *Pupa* was evidently not *P. vetusta;* and the correction was sent to Prof. Worthen, but was overlooked when my report on the county was printed. Upon showing the so-called *Zonites*, in its cleaned condition, to Mr. F. B. Meek, he at once recognized it as congeneric with a minute species, *Anomphalus rotulus*, described by Meek and Worthen from Macoupin Co., Illinois (Proc. Phil. Acad., 1866, p. 268). They refer the genus to the Rotellidæ: I am rather inclined to refer it to the Helicidæ.

I append descriptions and figures.

Pupa Vermilionensis, n. sp., Fig. 1.

Shell imperforate, spindle-shaped, tapering to an obtuse apex, covered with fine ridges (25 or 30 to the millimeter) parallel with the lines of growth. Aperture oblique, oval, rarely compressed. Outer lip thin, slightly reflexed. Columellar lip reflexed, thickened, furnished with a single central tooth projecting about 4^{mm}. Junction of columellar and outer lips sometimes angular and slightly dentiform. In old individuals, the columellar tooth is often continuous through an entire turn or farther—not seen on shells having less than three turns.

Adult shells consist of five or six turns. Last turn forms nearly half of the shell. Turns rounded. Suture impressed. Surface glossy. Color bluish black.

Total length, 3·6mm.; width, 2mm.

Anomphalus Meeki, n. sp., Fig. 2.

Shell broad, depressed, helicoid; spine obtuse, consisting of 3 or 3½ turns. Surface glossy, nearly smooth, showing, under a lens, fine oblique lines of growth too indistinct and irregular to be counted, perhaps fifteen to the millimeter. Aperture oblique, oval, greatly contracted by a broad lamellar expansion of the columella extending more than half way across, even in small individuals. Outer lip thickened, slightly reflexed. Suture slightly impressed. Each turn including only about half of the preceding one, thus distinguishing the species from *A. rotulus*, the type of the genus. Imperforate, but last turn slightly excavated in the umbilical region. Last turn more than half of the shell.

Total length, 3·2mm.; width, 4mm.

Art. XV.—*On Glacial Phenomena in the vicinity of New York City;* by R. P. Stevens, M.D.

The evidences of a glacier once moving over the island of New York are of three classes: 1st, The grooves or striæ, and other results of the abrasion of the rocks of the island, wherever they are visible. 2nd, The mantle of drift which partially conceals the rocks. 3rd, Facts observed over the hills of the neighboring island of Long Island. All the evidences of the first class show that the movement and agencies causing them proceeded from the northwest toward the southeast. I have made many examinations and measurements, from one end of the island to the other, and have never found any single instance to the contrary. My observations have also extended to Staten Island, New Jersey, and northwestward to the Delaware river, and up the Hudson river on both shores—and also over on the Highlands and mountains separating New York State from the States of Connecticut and Massachusetts. All my observations show the same general direction.

Since commencing this paper I have made many observations in the Central Park, and find the range to be from N. 20° W. to N. 30° W., or S. 20° E. to S. 30° E. Prof. Cooke, in his report on the Geological Survey of New Jersey, found all his measurements on the Palisades west of the Hudson river and opposite New York to lie between N. 20° W. and N. 75° W. The glacier, then, moved from the N.W., as Prof. Dana has

demonstrated it did in New England. Following this northwest direction from this island over the Highland range of "Archæan" rocks at the Ramapo Gap, N. Y., we find the same general evidence that we do elsewhere eastward. The same evidences can be seen in the Pompton Gap, Dover, and at Lake Hopatcong, N. J.

Some years ago I traversed the heights from this lake to West Point on the Hudson, and everywhere the evidence of some agent moving southeastward over them, rounding their summits, stossing them on their western slopes, was always present before me. The sum of all this evidence confirms Prof. Dana's theory of a glacial plateau on the highlands of Canada.

The second class of evidence—the material composing the mantle of drift—always shows it to have been transported from the northwest. Both on this island and Long Island the material is from rocks known to lie to the northwestward. Thus on the island we find boulders and huge masses of the serpentine and trap rocks of New Jersey blended with the red sand rock of the same State. In Brooklyn on Long Island we find, in addition to the rocks of New Jersey, those from New York island blended with the others. I have seen huge masses of anthophylite in Atlantic street, Brooklyn, which must have come from the parent bed of this rock on 10th Avenue and from West 50th to West 60th street. Careful measurement of the direction of the movement which must have transported these rocks shows it to have been from N. 10° W. to S. 10° E. This course tallies with measurements made on the palisades by Prof. Cooke. The agency which threw this mantle over the island had power to take up and transport immense masses of red sandstone from New Jersey to New York and Long Island. Many blocks in the city, as at East 73d, East 74th, East 75th, and East 76th streets, Third avenue, N. Y., lying beneath the surface soil, are four, six, and eight feet thick, giving in the excavations an appearance of being independent red deposits in the drift.

The third class of evidence is the immense drift deposits on Long Island. These stretch from Oyster Bay S. 60° W. to Fort Hamilton, and over to Staten Island. Was not this ridge a terminal moraine? Through this moraine the Hudson river breaks at the Narrows at almost right angles to the trend of the Hudson valley.

The material composing this moraine is made up of detritus from New Jersey and Manhattan Island. Boulders of trap, and gneiss and granite cover all the surface east as far as Oyster Bay. The shore of Long Island between Oyster Bay and Smithtown I have not visited. At the latter point, and along the Long Island railroad, beyond Brushville, there is an absence of all kinds of boulders. Underneath the surface the land is full of boulders of trap and gneiss through all the moraine.

On this island I have never seen any boulders of fossiliferous rock. They have, however, been seen by others. On the Jersey side I have seen them from the Corniferous limestone of the Roundout valley. Now, as this rock is not seen in the lower end of the Roundout valley, i. e., the northeast end, but in the southwest on the Neversink portion—we have in this instance further evidence of a movement from the northwest. Under this class of evidence we may notice the boulders of granular gneiss from Archæan rocks of the Highlands, which I have found as far east as East New York.

On the island of New York, in the deep excavations for subcellars for blocks of buildings, we often find modified drift, to the depth of twenty to thirty feet, entirely composed of clean washed sands—derived from the sandstones of New Jersey.

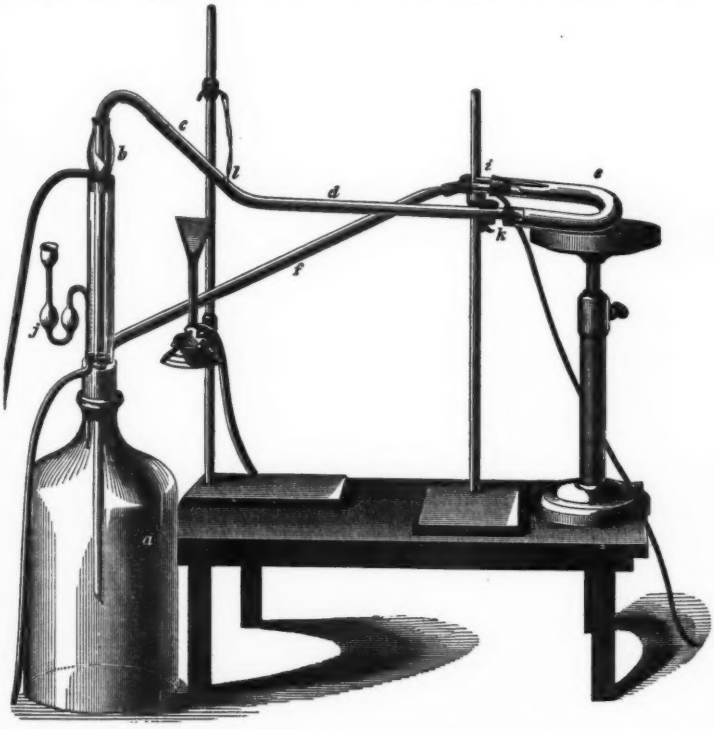
New York, 24 Pine St., June 17, 1872.

ART. XVI.—*Contributions from the Laboratory of the Sheffield Scientific School.* No. XXIV.—*On the Estimation of Sulphur in Coal and Organic Compounds;* by W. G. MIXTER.

THE determination of sulphur in organic substances by many of the methods in use is not only a difficult and tedious operation, but the amount of fixed reagents often employed greatly increases the liability to error. In the process here described, substances are burned in oxygen and the sulphur is condensed from the gaseous products in the form of sulphuric acid.

Experiments made by passing the products of combustion of sulphur-compounds through nitric acid failed to give satisfactory results. A variable loss was due to a dense white fume containing sulphuric acid, which was not completely absorbed by water or by caustic alkalies. The apparatus here described was designed for making the combustions in a confined volume of gas, to avoid this source of error. The bottle (*a*), see figure, has a capacity of from 4 to 10 litres, according to the amount of oxygen required. The neck should be large enough for a stopper 35 to 40 mm. in diameter. The condenser *b* is made of rather thin tubing 14 mm. in diameter; at the upper end it is expanded to a bulb in order to admit some motion to the tube *c d*. Below the bulb it is surrounded by a water-jacket 22 cm. high: from the point where it enters the stopper of the bottle it is narrowed somewhat for convenience of fitting. The combustion tube *c d* is made of hard glass of 12–15 mm. internal diameter; the portion *c* is 18 cm. from curve to curve, and is protected by a sheet-iron trough lined with asbestos; the part *d* is from 35 to 45 cm. in length. The wire attached at *l* is to sustain

c in case *d* breaks; *c* is joined to *b* by a collar of black-rubber. The U-tube *e* is connected with *d* by a rubber collar drawn over the latter at *k*; this U-tube is slightly inclined, that no liquid may run against the rubber connectors. The tube *f* connects *a* with *e;* it is narrowed at both ends to 10 mm. diameter, Near the upper end it is jointed by a piece of black-rubber



tubing in order that the apparatus may be easily disconnected at *k*. The ends of *f* extend 2 cm. or more beyond the stoppers. Through the rubber stopper *i* a small glass tube passes beyond the end of *f*, where it is narrowed to an opening of 1 mm. The double bulb tube *j* is to accommodate variations of pressure, and to admit air as the original volume of gas diminishes during the combustion. The tubes *b*, *c*, *d* and *f* should at no point have an internal diameter less than 8 mm.—10 mm. is preferable—and the narrowed ends should be cut obliquely that drops of water may not obstruct the circulation. The rubber stoppers and connections should be freed from adhering sulphur by heating in a solution of sodium hydrate. The joints

of the apparatus are sufficiently tight when water will stand in one limb of the safety tube.

The bottle *a* is filled over water with oxygen, and, if necessary, rinsed with distilled water; a few drops of bromine are poured in, the tubes adjusted and a slow stream of water made to flow through the water-jacket. The assay, if not volatile, is introduced into the tube *d* in a platinum tray*, which should not fill more than half the bore of *d*, leaving space enough for the free circulation of the oxygen. The part *c* is gradually heated and kept hot during the combustion. This hot inclined tube acts as a chimney; the heated gases rise in it, pass into the cold tube *b* and fall, thus causing a constant stream of gas to pass over the assay. It is important to ignite the assay without distilling off any considerable portion. To do this a small splinter of wood may be placed in contact with that part of the substance nearest *l*, or that end of the tray may hold a thin layer of the assay, which is heated as rapidly as safety allows by a lamp held in the hand. To ensure a full supply of gas in the tube *d* at the commencement of the combustion, oxygen is passed from a gasometer through the tube *i* till the white fume which appears in the condenser *b* passes into *a*. The products of combustion being denser fall to the bottom of the bottle, and for a while displace the oxygen, thus increasing the circulation. After the substance is ignited, the fire passes to the other end of the tray. The part of the tube about the tray is heated by a lamp as is required to keep up the combustion. At the end of the operation the heat is increased. If drops of liquid collect in *c*, and are liable to run down to the hotter parts of the tube, they should be driven off by heat. If carbonic acid be the principal product of the combustion, there is little change in the volume of gases in the apparatus; but if water and sulphuric acid are formed in much quantity, the volume is diminished and air enters through the safety tube.

Most solid substances heated alone in the open tray yield volatile products too rapidly for entire combustion, but if mixed with sand in suitable proportion they burn slowly and completely. Liquids should be enclosed in narrow tubes sealed at one end and drawn out at the other to a capillary bore for two or three inches of length. Upon the point of the tube a bit of platinum sponge is fixed to assist the oxidation. The liquid should not fill more than two-thirds of the wider part of the tube.

Before introducing very volatile substances, the 10 cm. of the combustion tube *l d* should be heated to dull redness.

* A platinum tray which answers well may be made 10 to 20 cm. long, 10 mm. wide, and 7 to 10 mm. deep by bending thin foil over a glass tube. The ends may be roughly bent together or left open.

Oxygen is passed in at *i*, the tubes are disjointed at *k* and the tube holding the assay is then pushed in, till the platinum just reaches the heated zone. The apparatus being connected at *k* slow volatilization of the liquid is effected by cautiously applying a flame under the empty portion of the tube containing the substance, so as to maintain the platinum sponge in a steady glow. As soon as a cloud of combustion-products appears in the vessel *a*, oxygen is shut off from *i*. When all the liquid has distilled from the interior tube, the tube *c d* is cooled slowly and the apparatus is left for two hours or until the fume has entirely subsided. If no odor of bromine be perceptible when the apparatus is disconnected at *k* to remove the tray or tube, a few drops of it should be poured through a funnel-tube put in the place of *j*, and the whole allowed to stand some time to ensure complete oxidation of the sulphur-compounds, and deposition of the sulphuric acid.

The tubes *d* and *e* are then rinsed into a beaker, this water is poured into *b*, which is then thoroughly washed by the aid of the wash-bottle; the large rubber stopper is lifted from the bottle and the lower part of *b* rinsed; without removing the tube *f* from the stopper, it is rinsed into a beaker and finally the bottle is carefully washed. The solution obtained, which need not exceed 500 cc., is evaporated to a small volume, filtered if necessary and the sulphuric acid precipitated by barium chloride. The barium sulphate washes easily, as the solution contains no nitrates or fixed salts. Its purity is ascertained by treatment with water and a few drops of chlorhydric acid, warming some time, filtering and reweighing. In case the substance leaves an ash or residue in the tray, this must be dissolved in aqua regia, the nitric acid removed by evaporation with strong chlorhydric acid, and any sulphuric acid it may contain separated in the usual manner. In the use of this apparatus there is no danger from explosions if care be taken to have the combustion tube hot enough to ignite combustible vapor. Before attempting to burn a substance in the apparatus, it is best to try it in a large inclined tube open at both ends, or with oxygen supplied at the lower end. Such a preliminary trial will usually indicate the precautions necessary in burning the substance in the apparatus.

The writer found that when oxygen prepared from a mixture of potassium chlorate and manganese dioxide, or from the chlorate alone (no rubber stoppers or connections being employed) stood some time in a bottle containing a few drops of bromine and a little water, the water gave a slight turbidity with barium chloride. Neither the bromine nor the solution of the chlorate gave reactions for sulphuric acid; the manganese dioxide contained, however, a trace of sulphur. Combustions

of alcohol and of sugar-charcoal made by the method here described, yielded with barium chloride, a precipitate apparently no greater than that obtained from the oxygen alone, and too slight to influence ordinary results. This shows that with suitable care rubber stoppers are not objectionable.

The following results, obtained in the order they are given, show the applicability of the method, while some of the details mentioned may help to explain the use of the apparatus.

		Weight taken.	Per cent. found.
1.	Iron pyrites (mixed with carbon),	0·0658	51·20
2.	" "	0·0597	51·26
3.	Sulphur,	0·2070	99·76
4.	"	0·2807	99·92
5.	"	0·4951	99·93
6.	"	0·5882	100·02
7.	Carbon disulphide,	0·7725	84·12
8.	" "	0·4598	84·16
9.	Bituminous Coal,	0·6640	2·97
10.	" "	0·7860	2·99
11.	Wool,	0·4640	3·44
12.	"	0·4675	3·46
13.	Tobacco,	2·0720	0·37
14.	"	2·1370	0·36

Nine liters of oxygen were used in Nos. 1, 2, 13 and 14, and four liters in each of the other analyses.

In No. 1 the iron pyrites was mixed with 1·3 gr., and in No. 2 with 2 gr. of sugar-charcoal, and the residues remaining after the first combustion were mingled with a small additional portion of charcoal, and the combustion repeated to remove the last traces of sulphur. The solutions of the final residues in aqua regia, after evaporation nearly to dryness to expel the excess of acid, gave no turbidity with barium chloride. The sulphur in this pyrites was estimated by another method by way of control.* This mixture of pyrites with charcoal was

* The analyses of pyrites were mostly made by a modification of the method of Storer and Pearson (this Journal, xlviii, 190). The pulverized iron pyrites (0·2-0·5 grm.) was mixed with thrice its bulk of powdered potassium chlorate, about 25 cc. nitric acid, sp. gr. 1·40 were then added to the mixed powders, and the whole was heated cautiously but not to boiling, for fear of melting the sulphur which separated. A complete solution was obtained in five to ten minutes. It was evaporated to dryness and the evaporation twice repeated with the addition of chlorhydric acid. The barium sulphate was finally precipitated from the solution containing but a few drops of free acid. It was washed first by decantation with water, was then digested with three separate portions of ammonium acetate, and the washing was continued with water till sulphuric acid gave no turbidity in the washings. These precipitates after ignition yielded no barium-salts to hot dilute chlorhydric acid; they were slightly reddish in color, and the sulphur calculated from their weight amounted to 51·69 and 51·73 per cent. respectively.

In two other determinations, potassium-sodium tartrate (no pure tartaric acid being at hand) and chlorhydric acid were added to the solutions before precipitating, with the hope of retaining the iron in solution more perfectly; the barium-

used as an imitation of coal, which should contain a known amount of sulphur.

The sulphur used in Nos. 3, 4, 5 and 6 was purified by crystallization from carbon disulphide solution and fused. It was placed in a narrow weighed glass tube from 5 to 7 cm. long, boiled, allowed to cool and the whole weighed. During the combustion of No. 4, the sulphur volatilized so rapidly at one time that a portion escaped unburned, and formed a coating in the neck of the combustion tube and in the condenser, which soon disappeared, probably oxidized by the action of sulphuric acid and bromine.

The carbon disulphide was the commercial article purified by distillation from calcium chloride and quick lime. The boiling point was constant. The per cent. of sulphur calculated is 84·21. On account of its volatility and resistance to the action of bromine, it required more care in its combustion than pure sulphur. It was weighed in a sealed tube having a neck three inches long with a very fine bore. The end of this neck was broken off, and the open point was thrust into a cylinder of platinum sponge wrapped in foil, and the whole was quickly placed in the combustion tube as has been described.

The powdered bituminous coal was burned in a tray. In Exp. No. 10 some tarry matter passed into the condenser. No sulphur was found in the reddish ash, which amounted to 5·57 and 5·22 per cents.

The wool was from South Down sheep. It was purified by washing with soap and afterward with ether, and was dried at 212°. Wool swells so by heat that it cannot conveniently be burned in an open tray. No. 11 was contained in a glass tube sealed at one end. After the volatile matters had been burned off, the tube was taken from the apparatus, the closed end was broken and the charred residue mostly transferred to a tray, which together with the tube was returned to the combustion

sulphate was treated as above described. The precipitates had notwithstanding a reddish color and corresponded to 51·78 and 51·63 per cent. of sulphur respectively. They yielded nothing to dilute chlorhydric acid, and were accordingly free from adhering barium-salts. They were, according to the suggestion of Mitscherlich (Jour. Prakt. Chem. 83, 456), dissolved in strong sulphuric acid, thrown down by water, washed and again weighed. They were now free from iron and corresponded to 51·28 and 51·40 per cent. of sulphur respectively.

In another estimation the barium-sulphate which contained a large amount of ferric oxide was slightly washed with water, then fused with sodium-carbonate extracted with water, and the sulphuric acid thrown down from the aqueous solution after addition of a slight excess of chlorhydric acid. The barium-sulphate, thus obtained free from iron, was digested with ammonium acetate, and finally washed with water. The sulphur calculated from it was 51·27 per cent.

The latter plan of purifying barium-sulphate has long been employed by Prof. O. D. Allen in the analysis of iron ores, and its publication was made nearly simultaneously in the Am. Ed. of Fresenius' Quantitative Analysis, p. 525, from notes furnished by Prof. Allen, and in a paper by Fresenius in his Zeitschrift, x, 52.

tube to complete the oxidation. In No. 12 a small platinum tube, extemporized from foil, closed at one end by a glass plug, was employed.

The pulverized tobacco of No. 13 was burned in an open tray, and the combustion occupied less than five minutes. A small amount of hydrocarbons passed over unconsumed, and owing to the intense heat a white sublimate formed above and beyond the tray. No. 14 (same tobacco) was mixed and covered with sand; the combustion lasted twenty minutes, and the oxidation was complete. The ash of the tobacco retained by far the larger part of the sulphur. In Exp. No. 13, 0·11, and in No. 14, 0·03 per cent. sulphur was obtained from the gaseous products. Mr. E. S. Breidenbaugh found in the same sample by Reichhardt's method* 0·36 per cent.

It is plain that the sulphuric acid of the gaseous products is obtained by this process under conditions highly favorable for its exact estimation. The solution from which it is precipitated contains no fixed salts and no nitric acid, the presence of which renders the barium sulphate difficult to purify, but only sulphuric and bromhydric acids. The only impurities that can attach to the barium sulphate are accordingly barium chloride and bromide. The former may be perfectly removed by warming the ignited precipitate with dilute chlorhydric acid, as Fresenius has conclusively shown in a late paper.† This method of purifying the barium sulphate has also the sanction of Bunsen.‡ It is not probable that barium bromide would resist treatment which removes the chloride. In the analyses given the writer added barium chloride slowly to the concentrated boiling solution, and after twelve hours or more decanted the supernatant liquid, boiled the precipitate with two or more portions of water and washed with hot water till sulphuric acid gave no turbidity in the washings. The precipitate washed rapidly, and an hour to an hour and a half generally sufficed for the largest ones. In purifying the larger precipitates, they were placed in a beaker with from 50 to 100 cc. water and a few drops acid. Any lumps were broken up by a rod, and the whole was boiled half an hour or more. The smaller precipitates were treated in the crucibles. In all cases the purifying was continued till sulphuric acid gave no reaction for barium salts in the last filtrate. The precipitates, weighing from 2 to 4 gr., lost by digesting with dilute chlorhydric acid from 0·007 to 0·020 gr.

To Professors Johnson and Allen I desire to return thanks for their assistance and for many valuable suggestions.

Sheffield Laboratory, July 1st, 1872.

* Caldwell's Agricultural Qualitative and Quantitative Analysis, p. 246.
† Zeit. für Anal. Chem., Bd. ix, s. 52. ‡ Zeit. für Anal. Chem., Bd. x, s. 396.

ART. XVII.—*On the Address before the American Association of Prof. T. Sterry Hunt;* by JAMES D. DANA. No. II.

THE aim of Professor Hunt in the latter section of his Address was apparently to show that all writers on metamorphism were deeply in error, except himself and a small circle of honored savants sufficient in number for a new School in that department of science. And in my reply it was my purpose, laudable, as I thought, to let him know that Delesse and Naumann were not to be depended on for the school; and, further, to show that the views of the outsiders were not altogether "contrary jargon," as he, in his intense love of truth (*i.e.*, *his* truth) had said, hoping by this last to quiet that vexation of spirit which had been excited by the alleged "sophistries." But in the reply to my criticisms (page 41 of this volume) Mr. Hunt still persists in denouncing multitudes of men for opinions they do not hold, and in claiming Delesse and Naumann as on his side. He throws out long statements against my eleven positions; yet, I have to say, without essentially weakening them. The multitudes do not need my further aid in their defense; and still it seems best once more to state the facts with regard to Professor Hunt's misreadings and misrepresentations. It is plain that for some reason he is yet unable to read rightly the opinions of others.

I will, therefore, set forth again those of my objections to which Prof. Hunt has replied, following the order nearly of his paper, and add such remarks as seem necessary.

Objection 1. *That Professor Hunt, while accepting the ordinary views on the origin of most pseudomorphs, rejects them with respect to many silicates, such as those consisting of serpentine, steatite, and pinite.*—I gave the reasons why crystals of serpentine and other similar pseudomorphs are not true crystals, mentioning facts that establish this, as I believe, beyond question. Mr. Hunt's only reply is: "Until we can watch the transmutation of one of these species into another, the argument from supposed intermediate forms is worth no more in the mineral than in the inorganic world." Thus chemical ignorance as to the how, in his use of scientific logic, is made to set aside all arguments as to the fact. The comparison he uses, if hard on Darwin, is not so on the crystallographer. The change of a crystal making it a pseudomorph is simply a chemical change without a change of form by means of hot or cold mineral solutions or vapors (agents that have been common in the course of the earth's history); and since very many such changes, as Mr. Hunt admits, have taken place among species not silicates, some of them yet

unexplained, the above argument is poor support for the conclusion that they may not have occurred among silicates. In this country no investigator of pseudomorphs has shown any leaning toward Mr. Hunt's "more rational" view, and only one or two in Europe.

But, further, the gradations in the transmutation have been in many cases seen, if not watched, so that direct observation of this kind has satisfied almost everybody else. Naumann holds to the derivation of serpentine from chrysolite, and states that large crystals occur at Snarum that are all serpentine excepting a remaining kernel of chrysolite at the center. Mr. Hunt would say that this is a case of cotemporaneous crystallization of the two minerals, or of *envelopment*. But the last step occurs also in the same region, that is, crystals of pure serpentine, with no chrysolite left and therefore nothing to envelop, and yet not having the qualities of true crystals, inasmuch as the interior physical and optical characters do not correspond to the crystalline form; and this, as the final step in the process, Naumann and the "many others" would say makes it a well-clinched demonstration.

Objection 2. *That Mr. Hunt claims that Delesse sustains a "theory of envelopment," as a substitute for the ordinary "theory of pseudomorphism," and in this denies Delesse's own statements.**— From the example just mentioned it is plain what is here meant by *envelopment*—that it is mixture from cotemporaneous crystallization. A considerable part of Prof. Hunt's reply on the above point is an endeavor to make what Delesse says on envelopment in crystals a substitute for what he says on pseudomorphism; when the truth is reached by taking Delesse's word for it, that his chapter on envelopment is introductory to the other,† a

* In my former paper I used, instead of the word *sustains*, the expression *is the author of*. Mr. Hunt claims rightly that Scheerer first brought out the idea of a kind of envelopment. But, as is obvious above, the question of authorship has nothing to do with my argument. Delesse was the first to present, in a detailed and systematic form, the facts connected with envelopment in crystals, and this word envelopment, as thus employed, is from him. Moreover, his idea of "envelopment" did not embrace Scheerer's principle, which was that of *isomorphism*. As Mr. Hunt has it, in this Journal, II, xvi, 217, Scheerer had in view a simultaneous crystallization of two *isomorphous* species, as, for instance, a hydrous and anhydrous silicate (iolite and fahlunite in the same crystal being an example). But Delesse's envelopment is simple mixture; he has no allusion in his chapter on envelopment to any *isomorphism* in the associated minerals. Mr. Hunt's sentence in his Address (p. 47), claiming that Delesse's view in his work on Pseudomorphism "is identical with the view suggested by Scheerer," is therefore at fault. Delesse, later in the volume, mentions Scheerer's principle as a possible case under his "envelopment," as follows: "If, as Scheerer has remarked, water acts as a base in silicates, then anhydrous and hydrous silicates may crystallize together and be isomorphous:" and then follows the single example of the association of hornblende and diallage in euphotide.

† Delesse says, at the close of his chapter on envelopment, "Ce préambule sur l'enveloppement des minéraux était nécessaire pour l'intelligence du pseudomorphisme, qui va maintenant nous occuper."

showing of *what is not* a pseudomorph preparatory to explaining *what is*; and observing, also, that this second part, the main part of the work, is treated, with the exception of a few examples unessential to the point in dispute, just as is done by Haidinger and all other writers on pseudomorphs, and contains a table, many pages long, of true pseudomorphs, in which are those of *serpentine*, *gieseckite* (var. of pinite), *steatite* or *talc*, *sepiolite* and *chlorite*, besides other silicates. There is no fog in Delesse's statements on this point. Mr. Hunt cites some seemingly opposing sentences from Delesse: but these relate to the exceptions, cases that for the most part are generally admitted to be doubtful; they do not touch the species abovementioned, those with regard to which Mr. Hunt would be glad to gather support from Delesse.

Prof. Hunt says that Delesse's views underwent a change about 1861, as appears in his work on metamorphism then published, in which Delesse "adopts" Mr. HUNT'S VIEW, that *beds* of serpentine have been formed from the alteration of chemically deposited beds of a hydrous magnesian silicate related to sepiolite (meerschaum). But the evidence is positive that, while Delesse accepted this hypothesis for *beds* of serpentine, he did not change his views on serpentine pseudomorphs. For in the successive numbers of his "Revue de Géologie," published by him and de Lapparent between 1860 and the present time, he sets forth the very same principles that are the basis of his work on Pseudomorphism (1859), and adds to the number of cited facts under both the heads *Envelopment* and *Pseudomorphism*.

In the number of the Review published in 1861, the very year his paper on metamorphism appeared, after citing a long list of cases of envelopment from an article by Söchting, he mentions cases of pseudomorphs of *steatite* after pectolite, analcite, natrolite and barite. In that issued in 1865, he commences (p. 169) his chapter on pseudomorphs with the following paragraph: "Lorsqu'une substance conserve sa forme primitive, bien qu'elle soit plus ou moins modifiée dans sa composition et même entièrement remplacée par une autre substance, il se produit ce que l'on peut appeler un pseudomorphisme. Ce phénomène a souvent lieu sur une grande échelle, comme l'a surtout fait remarquer M. G. Bischof, et par conséquent son étude est importante pour la géologie." Delesse here goes so far as to say (and this in 1865, it should be noted) that *pseudomorphic changes have often taken place on a grand scale, as has been especially remarked by G. Bischof, and consequently its study is important to geology.* He then cites a table of pseudomorphs, in which occur three of *serpentine*, one after actinolite, another after asbestus, and a third after bronzite; and this he does without a word of protest or objection, just as he did in his treatise of

1859. Again, in the Review published in 1872, after stating the fact of the occurrence of magnetite in mica, ascertained by Prof. Brush, as an example of *envelopment*, he next mentions a pseudomorph of *talc* after enstatite. Thus he declares his belief in the old views to the present year, excepting, as I have said, only a few species not bearing on the question here under consideration. Delesse, in adopting in 1861 the hypothesis with regard to *beds* of serpentine just stated, did not assume or imply that serpentine pseudomorphs or crystals were so made. He was aware that the method was wholly inapplicable to pseudomorphs, knowing well that a serpentine pseudomorph of chrysolite had been made by the alteration, not of a hydrous magnesian silicate, but of a crystal of chrysolite; that a serpentine pseudomorph of hornblende had been made by the alteration or removal of a crystal of hornblende; and the same in other such cases of "epigenic" pseudomorphism. For this is the view he presents.

Mr. Hunt attempts to explain Delesse's combination of opinions by "hazarding the conjecture" that Delesse wrote his views on envelopment and metamorphism "while he still inclined to the views of the opposite school." Thus, Delesse's direct and consistent account of his views is set aside on the ground of stupidity, or his not knowing clearly what he believed—a damning apology for Delesse, Engineer-in-Chief of the Mines of France, if it were needed: but, not needed, most damaging to the argument of his apologist.*

OBJECTION 3. *That Prof. Hunt makes Naumann sustain the theory of envelopment, when, in fact, this veteran crystallographer and mineralogist presents the ordinary views on pseudomorphism in the successive editions of his Mineralogy down to the last of* 1871. In reply to this Mr. Hunt adds one more sentence to the citation in his Address from Naumann's published letter to Delesse. But Naumann's letter related only to Delesse's ideas on envelopment, and is utterly misused by Prof. Hunt. I repeat from my former article that Naumann's chapter on Pseudomorphism contains not a word on envelopment, while it does present the old views; and his work is full of examples according therewith. Even fahlunite and some related species are admitted to be (p. 455, note) products of the alteration of iolite,† contrary to Scheerer and Hunt.

* In my review, I did not say, as Mr. Hunt implies, that Delesse *does not in any way countenance the views* of Mr. Hunt, for I remarked that he did agree with him with regard to the origin of *beds* of serpentine, and with respect to the envelopment nature of a few of the kinds of pseudomorphs; but I did say that with regard to pseudomorphs of serpentine and all the species under dispute, as well as most other kinds, and with regard to the use to be made of the facts under envelopment, Delesse holds directly opposite views to those of Mr. Hunt.

† Naumann, in the note here referred to in his Mineralogy of 1871, alludes to Haidinger's "excellent article" on the relations of fahlunite, chlorophyllite, pinite,

Mr. Hunt protests against expressions cited by him from Naumann and Delesse being "set aside because *traces* of the doctrine of epigenic pseudomorphism still hold a place in the last edition of Naumann's Mineralogy, or in the 'Revue de Géologie,' of which Delesse is one of the authors." *Traces!* when a systematic statement of facts on pseudomorphism essentially after the old views is the object of each! TRACES!!!

Delesse and Naumann might well be excused for some vexation of spirit after such "sophistries" personal to them, and, probably, if they were to speak out, they would show their vexation without the use of poetry.

OBJECTION 4. *That Prof. Hunt grossly misrepresented the views of nearly every writer on pseudomorphism in saying that the doctrine of Gustaf Rose, Haidinger, Blum, Volger, Rammelsberg, Dana, Bischof, and many others, leads them to maintain the possibility of converting almost any silicate into any other; and adding, in the same paragraph, that "in this way we are led from gneiss or granite to limestone, from limestone to dolomite, and from dolomite to serpentine, or more directly from granite, granulite or diorite to serpentine at once, without passing through the intermediate stages of limestone and dolomite."*

Prof. Hunt seems to think that he meets the objection in saying (page 50) that—

HAIDINGER and others have held to the conversion of limestone to dolomite;

G. ROSE, BLUM and the writer, to that of dolomite and some other rocks to serpentine, or to talcose, steatitic or chlorite schist;

RAMMELSBERG ———? [nothing is mentioned];

BLUM, again, to that of limestone to granite or gneiss, when this author has nothing of the kind in his works, and the nearest to it is the fact cited by Bischof that feldspar occurs as a pseudomorph after crystals of calcite;

BISCHOF, MÜLLER, and VOLGER, to that of various rocks into others by extravagant methods; and

DANA, again, ———! [see below].

But this gathering of objections from the opinions of a variety of individuals, and then charging the whole, with the help of a few lines of poetry (see Address, p. 42), on all collectively, while it may be a smart thing to do, is not the best course to give success to the truth. With scarcely an exception, all writers on the subject under consideration, Naumann and Delesse included, have a right to feel badly at being so summarily knocked over in ten-pin style.

etc., to iolite [showing that they are *altered* iolite], and then observes that these minerals are to be marked as independent species only "so far as they correspond to *definite stages or phases in the decomposition of iolite*." There is no mistaking Naumann's opinion.

But the most extraordinary feat is Mr. Hunt's making out that the writer has virtually sustained the view of the *metamorphosis of granite or gneiss to limestone* (p. 50), when, as I said before, it is an idea that never entered my head until the reading of Mr. Hunt's caricature of the subject. The proof which he gives is remarkable. In the first place, he says that my Mineralogy contains the fact that calcite is sometimes found pseudomorphous after quartz; and, in another place, the fact that calcite is found pseudomorphous after feldspar. Hence the conclusion, *granite or gneiss to limestone.* Q. E. D.

Now, if the facts respecting the pseudomorphs *were facts*, it would still require great constructive powers to make out from the statements the conclusion that I ever held to the "metamorphosis of granite or gneiss into limestone." But, as to the facts: (1) The mineralogy *does not* mention any case of the pseudomorphism of calcite after quartz; and (2) the pseudomorphs of calcite after feldspar are spoken of as examples not of an *alteration* of the feldspar, but of its removal, and the substitution of calcite (4th edit., p. 249, and also 5th edit., p. 361). Now, by this substitution process, the above-mentioned metamorphosis would consist (*supposing* fact No. 1 to be a fact, and that mica crystals may be similarly changed to calcite, which Mr. Hunt omits to include) in a removal of all the materials of the granite by a process of solution, and the cotemporaneous or subsequent substitution of calcite!

All will admit that the use of facts and not-facts exhibited in the above charge is most extraordinary; and can judge from it, and from other like cases stated, of Mr. Hunt's ability to appreciate, or do justice to, the views of others.

In accordance with the opinions on the origin of serpentine rocks which I hold, in common with Gustaf Rose and others, we learn from Prof. C. U. Shepard (see this Journal, iii, 237, 1872) that specimens of serpentine from the vicinity of Havana (Cuba) are plainly, as he says, pseudomorphous after chrysolite, amphibolite, augite, and titanite, and that these pseudomorphs so abound in the matrix, that they constitute the largest portion of the mass, and may be easily separated by a blow of the hammer.* Again, Mr. T. D. Rand states (this volume, p. 71, from the Proceedings of the Academy of Natural Sciences of Philadelphia, 1871, 302) that a serpentine and steatite rock on Mill Creek, Pa., near the line between Philadelphia and Montgomery counties, contains crystals partly cruciform which have precisely the form and angles of staurolite (as ascertained by running lead into the cavity left by one of them, and thus obtaining a cast), and which yet consist of serpentine;

* It is to be noted that serpentine pseudomorphs are sometimes pseudomorphs *by substitution*, as well as *by alteration*. Either method is a result of "epigenic" change, since it is produced by the action of external chemical agents.

and Mr. Rand adds that "the whole aspect of this curious formation suggests a rock originally containing crystals, but metamorphosed almost beyond recognition." Remembering what rocks contain crystals of staurolite, that they are usually mica schist, or clay slate, we learn here some of the probabilities as to the kinds of rock that may have undergone this change to steatite and serpentine. The argument with regard to the magnesian alterations is not from simple crystals alone, but from these and the rock combined.

In view of such facts, the writer still holds, as in 1845, that—

* * * "The same causes that have originated the steatitic scapolites, occasionally picked out of the rocks, have given magnesia to whole rock-formations, and altered throughout their physical and chemical characters. If it be true that the crystals of serpentine are pseudomorphous crystals, altered from chrysolite, it is also true, as Breithaupt has suggested, that the beds of serpentine containing them are likewise altered; though often covering square leagues in extent, and common in most primary formations. The beds of steatite, the still more extensive talcose formations, contain everywhere evidence of the same agents."—*This Journ.*, xlviii, 92, 1845.

Besides this paragraph, expressive of my views, Mr. Hunt cites also another of the same purport from my Mineralogy of 1854, and in this, also, I see little to modify. It is as follows: that—

"The various examples of pseudomorphism should be understood as cases not simply of alteration of crystals, but in many instances of changes in beds of rock. [Delesse admits this; see p. 99.] Thus all *serpentine*, whether in mountain-masses, or the simple crystal, has been formed through a process of pseudomorphism, or in more general language, of metamorphism; the same is true of *other magnesian* rocks, as steatitic, talcose or chloritic slates. Thus the subject of metamorphism, as it bears on all crystalline rocks, and of pseudomorphism, are but branches of one system of phenomena."—*Min.*, *4th edit.*, i, 226.

The larger part of the kinds of alteration or metamorphism made out against authors by Prof. Hunt, on pages 50, 51 of his article, are of this *magnesian* class, the results being serpentine, or talcose, steatitic or chlorite schist. It is to be remembered that this class is but one among several that have been made by metamorphism. If we use, as above, the argument from hydrous magnesian pseudomorphs to hydrous magnesian rocks, we are not chargeable with applying a like argument to the origin of calcite from gneiss or granite, or the reverse, until we so apply it. There is no like basis in pseudomorphism for such conclusions. This is made manifest, for one of them, in the explanation of Mr. Hunt's "extraordinary feat" on the preceding page; and the other is equally preposterous.

Objection 5. *That Prof. Hunt's Address of* 1871 *misrepresents my views in attributing to me the doctrine that "metamorphism is pseudomorphism on a broad scale," without alluding to the views I actually now hold as presented in the chapter on Metamorphism in*

my Manual of Geology published in 1863.—Mr. Hunt's reply to this is simply that I once held the view and have never formally retracted it—as if presenting other views in a formal chapter on the subject were not a sufficient retraction. As to my own expression of the doctrine that "metamorphism is pseudomorphism on a broad scale," he brings out a fact I had overlooked when writing my former article. I examined the Mineralogy, and all my papers in this Journal, in search of the line above cited, and failed to find it because of its occurrence only in a short book notice. I did not deny having used it, though ignorant where or when, but only asserted that it was not in the Mineralogy. The statement in my article as to the views contained in the Mineralogy (4th ed.) is strictly correct. My general expressions in that work are strong; but I mention as examples, under those views, no rocks except serpentine and other magnesian rocks; and to these, as I have said, I still apply it. See, for my views in 1854, the sentence on the preceding page, cited from it. Moreover I state, in the same chapter (p. 336), that *few will follow Bischof in all his methods of rock-making.*

Objection 6. *That Prof. Hunt points out the existence of a Green Mountain series of rocks, and a White Mountain series, basing his deductions largely on lithological evidence, without any sufficient stratigraphical evidence, and without properly defining the limits of the two regions.*—Mr. Hunt's reply to these objections are confined to three points. (1.) In opposition to my remark "that there are gneisses, mica schist and chloritic and talcoid schists in the Taconic series," he says "that Emmons, the author of the Taconic system, expressly excluded therefrom the crystalline rocks." This exclusion is an easy feat for a speculator with pen in hand, like many closet feats; but it is more than herculean in actual fact, since the very Taconic mountains themselves, that is, the very rocks called Taconic by Emmons, are partly gneiss, gneissoid mica schist, and chloritic talcoid schist, as well as talcoid schist; and these rocks are so involved together that speculation will never bring them into that kind of order which Mr. Hunt's "notions" require.

(2.) To my enquiry whether any one has *proved* by careful observation that crystals of staurolite, cyanite or andalusite are restricted to rocks of a certain geological period, Mr. Hunt answers that "it has not yet been proved that they belong to any *later* period than the one already indicated" (the Pre-cambrian); and that "it is only by bringing together observations, as I have done, that we can ever hope to determine the geological value of these mineral fossils." Now the fact is that those same Taconic rocks, unquestionably of the Taconic system according to Emmons himself, and, therefore, Hunt attesting, of

Lower Silurian age, contain in some places staurolite crystals. Percival first noticed the fact, and states this even of the rocks of Mt. Washington, the main part of the Taconic range. He speaks of the rock of "Taconic mountain" as fine-grained micaceous or talco-micaceous schist, containing garnet and *staurolite;* and adds, "sometimes it is greenish and subchloritic, with seams and patches of compact green chlorite, and yet accompanied with the same minerals [garnets and staurolites]. This is particularly the case in the south and northeast part of Taconic mountain." Hence staurolites, and chlorite also, occur in rocks admitted to be Silurian.

(3.) Mr. Hunt denies that he makes, in his Address, "the crystalline schists of the White Mountains a newer series than the Green Mountain rocks."—I had read on pages 29 and 33 of the Address approving announcements that Macfarlane had made the crystalline rocks of the Green Mountains *Huronian;* and then, on page 34 of the Address, the statement that the White Mountain series is largely developed in Newfoundland, and that this fact had led him (Mr. Hunt) to propose for it [the year before] the name of the *Terranovan* System. At this point in the Address there is a reference to this Journal of the preceding year, vol. l, p. 87, 1870; and consequently by referring back to this article by Mr. Hunt, I found this Terranovan defined, Mr. Hunt saying that, according to Mr. Murray, the series comprises "several thousand feet of strata, including soft bluish-gray mica slates and micaceous limestones belonging to the *Potsdam* group, besides a great mass of whitish granitoid mica slates whose relation to the Potsdam is still uncertain." As the Huronian is older than the Potsdam, and this equivalency of the Terranovan is not corrected in the Address, I thought I had reason for supposing that Mr. Hunt made the White Mountain series the newer. I acknowledge I prefer the view he now presents, since the less definite the statement the better as long as we have no sufficient facts for a conclusion.

ART. XVIII.—*Reply to a "Note on a question of Priority;"** by JAMES HALL.

IN the April number of this Journal there is published an article with the above title, in which the author questions the fact of publication of a small pamphlet entitled "Notes on some new or imperfectly known forms among the Brachiopoda." I perhaps owe to myself and to the scientific public a few words in reply.

*By E. Billings, who has treated the same question, essentially in the same style and manner, in two or more articles in the Canadian Naturalist.

The pamphlet referred to was printed in March, 1871, and a number between twenty-five and thirty copies delivered to me at that time. The type was left standing in order to print a larger number, to be accompanied by a plate of figures then in progress, with descriptions of the same. Of these copies, the greater part were distributed in the United States soon after publication. Copies were sent to the Geological Society of London, to Mr. Davidson, Mr. A. C. Ramsay, M. Barrande, Dr. Lindström, Dr. Geinitz, Prof. DeKoninck, Dr. F. Rœmer, Edward Desor, Dr. A. von Volborth, and the Imperial Society of Naturalists of Moscow. These, with one exception, were sent in packages with other publications, through the Smithsonian Institution, and are marked in my list as having been forwarded from Albany on the 7th of April, 1871. The pamphlet is noticed in the Jahrbuch for 1871, p. 989.

On the 7th of April, 1871, the printing establishment of Weed, Parsons & Co. was destroyed by fire, together with the 23d Report on the State Museum (printed to nearly 200 pages), the lithographic stones, and everything else pertaining to that work. In the confusion which followed, and with the necessity on the part of the State printer to furnish certain documents as soon as possible, no attention was given to the State Museum Report for several months. Had there existed in my mind the least doubt about publication, I should naturally have procured an additional number of copies; for this work could easily have been done at any printing office. It has usually been my practice to distribute at least one hundred copies of publications made in advance of the regular reports; and this would have been done in the present instance within a month after the first publication, together with the plate of figures, and description, but for the disastrous fire referred to.

These are the facts of the case; the scientific public will decide the question of publication.* And here I might close: but there are a few points in Mr. Billings' article which require attention.

From the tenor of Mr. Billings' statements in this Journal and especially in the Naturalist, any reader would suppose that I had borrowed specimens from the Canadian Geological Survey on which to found my descriptions, or conclusions, concerning the genera there published as RHYNOBOLUS and DINOBOLUS, and then endeavored to keep him in ignorance of what I had done. This would certainly have been an absurdity, and moreover it is not true. The only specimens borrowed of the Survey, having the remotest relation to RHYNOBOLUS, were of *Tri-*

* If the fact of being on sale with booksellers is necessary for publication, the question could certainly be raised regarding all the State Museum Reports; for the State of New York has never authorized their sale.

merella. I wished to compare authentic specimens of the latter with *Dinobolus*, which under the name of *Obolus Conradi* had been stated by Mr. Dall to be a true *Trimerella.* The idea of designedly keeping Mr. Billings in ignorance of what I had done would have been simply silly and purposeless.

The question regarding these oboloid forms had occupied my attention for a long time; and in 1862, I wrote to Mr. Davidson my views of *O. Conradi*,* sending a description and figures. Thus this was no new idea of mine; but the progress of my work in 1871 required some action on my part in order to prepare the supplementary plates of vol. iv, Pal. N. Y., and these were among the things to be first done. *Obolus Canadensis* I did desire to see, for I had known since 1854 that it was a new and distinct genus; and Mr. Selwyn did say that Mr. Billings was at work at *O. Canadensis*, but did not mention any Galt specimens or species. Mr. Billings says that his genus *Obolellina* "*is intended to include at least one of the forms described*" by him *as* "*Obolus Canadensis.*" It may include also RHYNOBOLUS, but I think that has not yet been shown by Mr. Billings' figures.

As an explanation of applying on "two occasions," I may say that I understood Mr. Selwyn's reply to my first letter to be a refusal, and the matter was of course dropped. Subsequently, Dr. T. Sterry Hunt, authorized by Mr. Selwyn, gave an explanation which induced me to renew the request. I was taking no advantage of Mr. Billings in any way, for neither himself nor Mr. Selwyn had indicated his intention in regard to Galt specimens, and those which I used had been in my possession since 1848.

As to the compact or agreement about describing New York or Canadian fossils, referred to and written about by Mr. Billings, I can only say that I never heard of it before now. I have alway had in my collections undescribed species of Canadian fossils, which I have refrained from describing from a natural sense of propriety. If I am not mistaken, Mr. Billings has derived much material from New York, by collectors sent expressly for that purpose, and I have no doubt has made good use of it; but I have never thought of complaining; and I have not entered into petty contrivances or insinuations to prevent fossils going into his hands. If Mr. Billings' published statements and private letters agree in regard to this matter, it is all that I can require.

* In my letter to Mr. Davidson, of date 31st October, 1862. I wrote—"I enclose you drawings of what I have proposed as a new genus of Brachiopoda. In some respects it is like OBOLUS, but is a large calcareous shell, in my opinion of quite a new type. I had originally communicated the description in my Wisconsin Report, but afterward withdrew it. Please give me your opinion of it. * * * I propose the name Conradia for this fossil."

In my letter to Mr. Selwyn, of the 10th of April, 1871, alluding to my work, I said, "The question of the Linguloid shells, OBOLUS and TRIMERELLA, was one requiring early determination;" and it was for this reason that I had desired to see the Canadian forms. I was certainly under the impression that I had previously given Mr. Selwyn full information of what I proposed to do; but if otherwise, this letter of the 10th of April was sufficient; and if after that no pamphlet was received, it seems a little remarkable that Mr. Billings should wait till the 30th of January following before making any further inquiries about it.

On the 23d of February, 1872, during my absence from Albany, a letter was received from Mr. Davidson, of date February 8th, in which my attention was called for the first time to this question of publication. I replied, stating the facts as I have done here. In a subsequent letter, Mr. Davidson discussed more fully the refusal of Mr. Billings to admit publication, and, as I understood the language, had proposed to refer the matter to several scientific gentlemen in England. I wrote quite agreeing to this, and, while feeling no doubt of the publication of my pamphlet, proposed a plan in which I consented to drop the name RHYNOBOLUS, thus hoping to prevent a controversy, and saving the *amour propre* of Mr. Billings. In the mean time Mr. Billings published the article in this Journal, and I wrote immediately withdrawing the proposition.

The public have here the facts. I have not been aware of any "unfortunate collision," nor of any cause for the succession of statements in the last page and a half of Mr. Billings' article against me, that "it is not my fault that this difficulty has arisen," etc.

It has unfortunately happened, in nearly all cases where I have proposed new genera during the last ten or fifteen years, that I have, according to Mr. Billings' expressed opinions, infringed upon his rights, or violated some rule of scientific procedure.*

I fully admit that the party at fault in this or any other case should be the sufferer. Mr. Billings has inaugurated and thus far managed both sides of what he denominates "this controversy," with his usual tact and adroitness. I have said nothing, while he has published I believe three or four articles on the subject. I have entered into no controversy, and hope to be saved from one. It will not distress me if my name of RHYNOBOLUS should not be adopted. Unquestionably the pamphlet should have been reprinted at once after the fire; but in such a condition of things as then existed, every one is naturally absorbed in *what appears to be the present duty*, and may easily for-

* For example, TRIPLESIA, RENSSELAERIA, MERISTELLA, STROPHODONTA, etc.

get some things which afterward may prove to have been of more imperative importance. I think this is the experience of the world, judging from the aphorisms ancient and modern.

I can say, however, in all sincerity, that had Mr. Selwyn or Mr. Billings at any time made me a civil statement of the facts, with a request to withdraw the name RHYNOBOLUS, I would unhesitatingly have done it, so far as in my power; and it would have given me great pleasure to show my good will toward every member of a corps with whose former chief I have been for more than thirty years in uninterrupted friendly and harmonious intercourse; and always in more or less intimate relations of friendship with every member of the staff, except Mr. Billings, who has chosen for himself an attitude of hostility without any reason or cause of provocation on my part.

With regard to the accusations and insinuations of dishonest purposes and practices, to which I at first felt inclined to reply, I shall say nothing at this time.

Albany, N. Y., May, 1872.

ART. XIX.—*On the Corundum region of North Carolina and Georgia, with descriptions of two gigantic crystals of that species;* by CHARLES UPHAM SHEPARD, Sr., Prof. of Natural History in Amherst College, Mass.

CORUNDUM has been recognized for above thirty years at several of the gold washings in the mountainous counties of North Carolina and Georgia, though rarely occurring in masses larger than would be called a coarse gravel. Upward of twenty years ago I received from Mr. Plant, banker at Macon, Ga., an hexagonal prism of this mineral of a ruby-red color, measuring one and a quarter inches in diameter by $\frac{3}{4}$ of an inch in height, said to have come from a gold mine in Habersham Co., Ga. About the same period, I was indebted to the Hon. T. Clingman of Asheville, N. Car., for several pounds weight of a coarse sapphire, derived from a crystal originally ten or fifteen pounds weight, that had been picked up at the base of a mountain on the French Broad river in Madison Co., N. Car. No farther discoveries of the kind appear to have attracted attention until the last two or three years. Within this period, however, under the stimulus of discovering an improved description of emery, many new localities of corundum have been brought to light in this region, of two or three of which I propose to give some account, derived from the examination of numerous specimens, and from information afforded by Rev. C. D. Smith and Col. C. W. Jenks of Franklin, Macon county,

N. Car., two gentlemen to whom we are chiefly indebted for the developments thus far made.

The corundum localities are already known to occupy a stretch of country at least 170 miles long, with a breadth of about ten miles. As the region is little inhabited and very mountainous, it is probable that the corundum zone, as it has been called, will hereafter be much extended. It is situated in a sub alpine country, partly within the northeastern corner of Georgia, and extending thence, in the direction of the crest of the Blue Ridge, into several contiguous counties of North Carolina. Beginning for example, in the northeastern corner of Jackson Co. (N. Car.), Mr. Smith sketches it, as running in a southwesterly course across Macon Co., where it strikes the Georgia State line, its general direction coinciding with the trend of the Blue Ridge until it reaches the head of Tennessee river, when it suddenly ceases on encountering the Nantegalee mountain (a spur of the Blue Ridge here running due north), to reappear 10 miles to the northwest on Buck creek; whence it pursues its original course of N.E. and S.W. across the Chunckygal mountains, where it again enters the Blue Ridge, and probably continues through several of the upper counties of Georgia, as Union, Habersham, Lumpkin and Hall. Thus far, the corundum is known to occur only in a single formation, which may be designated as chrysolitic rock; though from its color and some other peculiarities, it has often been confounded with serpentine. Strictly speaking, as will more fully appear farther on, it is not the true chrysolite, though containing this species to some extent, in an intermingled or disseminated condition.

This chrysolitic rock does not show itself as a continuous, uninterrupted belt or formation, throughout the tract above indicated; but exists in lenticular patches or beds, accompanied more or less by a hornblendic layer on one side (the southeast), and possibly on both sides; but the prevailing rock of the region—that enclosing the chrysolitic as well as the syenitic rock—is a gneiss, somewhat characterized by containing garnet and staurolite, as well as occasional deposits of iron and copper pyrites. The interruptions in the linear continuity of the chrysolitic rock vary in extent, from one to 15 miles; though these may in some cases be reduced, after a more careful survey of the country, The transverse diameter of the chrysolitic beds varies from half a mile to a mile, or even more in some places; but narrows down to 40 feet and less, as we approach the running out of the discs.

The principal exposure of the corundum has been effected at what is known as the Culsagee mine, situated in the township of Elegée (sometimes written Elijay) situate 8 miles S.E. from

Franklin Court-house, in Macon Co. This is the center of operations of the American Corundum Co., whose works are superintended by Col. C. W. Jenks. The chief excavations have been made on the northern slope of a mountain, at an elevation of about 2,700 feet above tide water. The strata here developed dip to the N.W. at an angle of about 45°, and exhibit the following order of formations, commencing on the N.W. side of the opening:—1, chrysolitic rock somewhat mixed with anthophyllite; 2, a layer of micaceous rock; 3, a seam of chalcedony; 4, a stratum of chloritic rock (ripidolite); 5, the same, through which the corundum is irregularly diffused, sometimes in narrow veins or widening out to several feet. The chloritic layers 4 and 5 do not possess the character of a true chlorite-slate, but constitute rather a coarse rock, in which the chlorite (ripidolite) is mostly in large crystals and foliated masses, segregated without order, much as mica is in large-grained granites; but what is here chiefly remarkable is, the entire absence of quartz. Narrow veins, containing besides the chlorite and corundum, a dark blackish green spinel (mostly massive), more or less mingled with black tourmaline, traverse layers 4 and 5, in various directions. The workings have been carried down to a depth of above 50 feet, and extend over a considerable space, without thus far establishing the existence of a concentrated stratum or vein for the corundum, similar to that at the Chester (Mass.) emery mine. I have not been informed as to the underlying rock of the above mentioned strata, but suppose it to be chrysolitic, which I am led to infer is the bounding formation of the corundum series, just as gneiss rock is of the chrysolite and syenite themselves. I am not accurately informed either respecting the aggregate thickness of the layers above mentioned, but infer that they are from 12 to 20 feet. As to their linear prolongation, nothing is yet established; but it is quite probable that it is not very considerable in proportion to the thickness of the beds; and it is most likely that the corundum-bearing layers themselves will be found to constitute a series of ovoidal or discoidal masses, often repeated over the chrysolic tract, inasmuch as the under soil and the beds of the brooks largely afford traces of a corundum sand and gravel, that must have originated from outcropings similar to that of the Culsagee mine.

I am informed by Col. Jenks that the corundum occurs under very similar circumstances at the Rabun Co. (Ga.) locality, situated on the road from Walhalla, S. Car., to Franklin, and 10 or 15 miles to the S.E. of that above described. At the Cullakence (sometimes written Cullakenih) mine, on Buck creek, in Clay Co., and about 15 miles to the S.W. of the Culsagee, the corundum, though contained in the same chrysolitic rock, is nev-

ertheless attended by quite a different series of minerals. The outcrop extends over three hundred acres. Arfvedsonite, zoisite, albite and margarite are here found as its most frequent attendants. The corundum is either white or gray like common feldspar, or else a delicate and often deep ruby-red color. No tourmaline or spinel have thus far been noticed, though occasional detached specimens of picrolite in long and rather coarse fibres are here found.

After this outline of the leading geological features of the corundum formation, we proceed to speak of it mineralogically: and first, it will be appropriate to treat of the constituents of the chrysolitic rock. As a whole, it has nothing but color to assimilate it to serpentine. Indeed it more resembles a certain fine granular variety of epidote,—its color often bordering on pistachio-green. Even where most exposed to the weather, its hardness =5·0 to 5·5; and in no instance, so far as I have seen, does it emit, on being moistened, the peculiar odor of serpentine. Where a partial decomposition has taken place, we only see a thin crust or coating of a ferruginous powder on the surface. Nothing soft or talcy appears, or any change indicating a metamorphosis to serpentine. Though usually quite homogeneous, it still contains in places considerable grains of true chrysolite, having the hardness and other properties of the unchanged species. It also embraces occasionally broad bladed crystals of that variety of anthophyllite known as gedrite; and also has diffused through its mass, very generally, minute octahedral crystals of chromite. Almost the entire aggregate, however, consists of what some would denominate an altered chrysolite, while others again may prefer to regard it as having been originally formed as now found. It has the following characters: Color yellowish olive-green; structure fine granular to compact: luster glimmering, vitreous. H.=5·5 to 6·0. Gr.=3·04 to 3·06. When heated to redness in powder, it turns pale cinnamon-red. Infusible. Easily attacked by hydrochloric acid, with which it forms a stiff semi-transparent jelly. Composition:

Silica,	41·49
Protoxide of iron,	8·62
Magnesia,	44·00
Water,	5·69
	99·80

with traces of the oxides of chrome and nickel. The foregoing characters obviously place this abundant mineral under the species villarsite.

The mineral next in importance is the green chloritic one already mentioned as the immediate gangue of the corundum.

It is that variety of chlorite properly called ripidolite. Much of it, even to a depth of 50 feet at the Culsagee mine, assumes a light pinchbeck brown color, constituting that modification of vermiculite (itself a hydrated ripidolite), called jefferisite. This brown mineral is in broad, highly crystalline foliæ and crystals, often attached to and forming portions of unaltered ripidolite, in which cases they are softer and more easily cleavable than the latter mineral. From this condition, they pass insensibly to a pulverulent, scaly, clay-like aggregate, much resembling the original vermiculite of Millbury, Mass., except in possessing a lighter color. The ripidolite has a blackish grass-green color, closely resembling that of the corundophilite, but unlike the latter, it emits on being breathed upon the peculiar chloritic odor; and before the blowpipe exfoliates, turns white and fuses on the edges into a grayish white glass; whereas corundophilite does not exfoliate, but turns black and melts on the edges into a black magnetic glass. The vermiculite (both varieties, the broad foliated and the fine pulverulent) exhibits on heating the usual exfoliation of the species. The soft and slightly coherent condition of the vermiculite where it happens to prevail in the workings, renders the separation of the corundum, especially that of the crystals, easy; whereas the ripidolite, when by itself, forms rather a tough gangue rock. Occasionally narrow seams of blue and white halloysite traverse the masses of vermiculite, among which also occur greenish-gray crystals of a softened hydrated arfvedsonite, a very ambiguous mineral, but recognized by its crystalline structure and easy fusibility before the blowpipe. Into this aggregate small scales of white margarite also enter.

The spinel appears to be confined to narrow irregular seams of a more closely grained ripidolite, mixed also with black tourmaline and corundum, which seams traverse irregularly the coarser ripidolite rock. Its color when massive is almost black, though its powder is blackish-green. Before the blowpipe, it gives the reaction of chromium. It possesses the peculiarity when in crystals (octahedra with truncated edges) of being thinly coated or varnished as it were, with a silky, pearl-gray envelope,—giving them so much the aspect of the altered zircons from Henderson Co., N. C., as to have caused them at first to be referred to that species. This coating has about the hardness of steatite or agalmatolite, and probably also a composition approaching one or the other of these substances.

Quite different appear to be the minerals associated with the corundum of the Cullakenee mine in Clay Co. Indeed the variety of corundum differs considerably from that of the region generally. It is less perfectly crystallized, and has a delicate

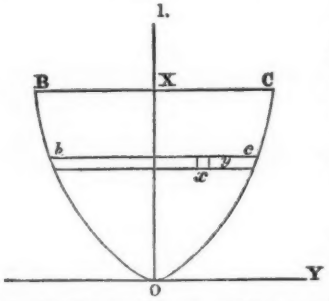
rose-red or pink as its prevailing color. The blue tints are wanting, so far as the specimens thus far submitted show; but a grayish-white, like that of common feldspar, is the most common shade. The most characteristic associated species would appear to be arfvedsonite of a grayish, brownish black color, often in crystals and coarse fibres interpenetrating the corundum. It also occurs in short crystals and even granular, of a rich grass-green color, coating or including small crystals and laminæ of the ruby,—constituting a rock of much beauty. This green or chromiferous arfvedsonite much resembles the most highly colored variety of omphacite, or eclogite with garnet from Hof Bavaria, but is quickly distinguished therefrom by its easy fusibility, attended with the soda colored flame so characteristic of arfvedsonite, in which peculiarity it precisely agrees with the brownish black and more perfectly crystallized variety. Instead of the disseminated garnet in the omphacite, we have the beautiful grains of ruby in the present aggregate. Zoisite is the next most characteristic mineral of this locality. It occurs in pretty distinct crystals and columnar masses of a pure white or slightly grayish white color, sometimes semi-transparent. The more massive variety is so intermingled with the corundum as often to be mistaken for feldspar. Albite is a third species that rarely enters into the composition of the corundum gangue. Margarite is wanting in the variety found in the green arfvedsonite, though a very deep sky-blue kyanite occasionally traverses the green aggregate in thin veins. It should be mentioned that this peculiar gangue of the red corundum shows a decided stratification like certain varieties of gneiss, that also embraces granular epidote, such as occurs at Grace mountain, in Warwick, Mass.

The foregoing include all the species I have thus far had submitted to my notice, as belonging to the corundum formations under consideration. The specimens did indeed embrace single examples of a pale actinolite, a white radiating asbestus and an isolated crystal of rutile, as well as one of a large and very beautifully colored epidote, but I am led to infer that neither of these minerals are in any sense characteristic attendants of the corundum of the region. One specimen of white, granular dolomitic limestone, containing scales of graphite, was sent, only as having been found in the vicinity of the Cullakenee locality.

[To be concluded.]

ART. XX.—*Ohm's Law considered from a geometrical point of view;* by JOHN TROWBRIDGE, Assistant Professor of Physics, Harvard College.

OHM'S law is briefly expressed thus: the strength of a current passing in any conductor of a resistance R is equal to the electromotive force producing the current divided by the resistance or $S=\frac{E}{R}$. Let us suppose that a certain quantity of electricity arriving at the point O, is transmitted by the conductor B O C to the surface B C. The quantity passing through any unit $x\,y$ of the conductor will vary inversely as the section $b\,c$, and inversely as the distance of the section from O.



Hence we shall have for an expression of this quantity $q=\frac{Q}{Sx}$ Eq. (1). In which Q represents the entire quantity passing through any section S; and x is the distance of the section from O. If we suppose that the conductor B O C is formed by the revolution of any curve, whose equation is $y=F(x)$, about the axis of X, equation (1) becomes $q=\frac{Q}{\pi y^2 x}$. By substituting for y its value from the equation of the curve which generates the conductor, we shall obtain equations which represent, when constructed as curves, the variations in the quantity of electricity passing through a unit section of the conductor.

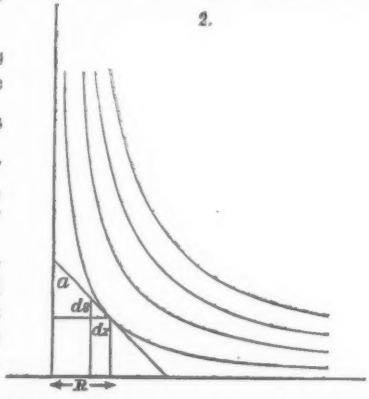
When the generating curve is $y^2=\frac{1}{x}$ the equation becomes $q=\frac{Q}{\pi}=$ constant; a straight line parallel to the axis of X. If the curve is an equilateral hyperbola, whose equation is $y=\frac{C}{x}$, we shall have $q=\frac{Q}{\frac{\pi C^2 x}{x^2}}=m\,x$ where m is any constant. This is the equation of a straight line passing through the origin. When the equation of the generating curve is $y=C'$ the conductor B O C becomes a cylinder; and $q=\frac{C}{x}$ where C is any constant. This is the equation of an equilateral hyperbola, and is iden-

tical with the equation $S=\frac{E}{R}$, which is our original expression for Ohm's law.

If we construct the various curves represented by the equation $S=\frac{E}{R}$, taking X as the axis of resistance, E being constant for each curve, we shall have a series of hyperbolas.

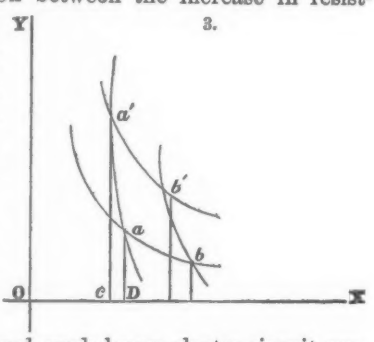
The series of curves represented in fig. 2 may be called isoelectric curves, and present some remarkable analogies to the isothermal curves of thermo-dynamics.

2.



Let $m=F(Sk)$ be the equation of the curve $a\,b$. The curve $a\,b$ will represent the relation between the increase in resistance and the decrease in tension. The curve $a'\,b'$ will represent this relation for $m+dm$. The two curves $a\,b$ and $a'b'$ differ from each other by a constant; the same is true of the curves $a'\,a$ and $b'\,b$, which are similar to the adiabatic curves of thermodynamics. Perhaps the subject is best exemplified by an application to the electromagnetic engine.

3.



"The performance of external work by an electro circuit produces a counteractive force whose magnitude is equal to the external work performed in an unit of time divided by the strength of the current.

"Let W be the external work performed in any unit of time by the engine. This gives rise to a counteractive force which causes the current to be of less strength than that which the battery produces when *idle*. Let γ be the strength of the current in the idle circuit, and γ' the strength when the work W is performed per unit of time; then the counteractive force is $\frac{W}{\gamma}$, and the strength of the current γ' is the same as if the electromotive force instead of being E were $E-\frac{W}{\gamma}$."—(*Prof.*

W. J. M. Rankine on the General Law of the Transformation of Energy, Phil. Mag., 1853.

In fig. 3, if we suppose that the electro-magnetic engine does work, the strength of the current will fall in passing from the resistance O C to O D, by reason of the counteractive force, to the lower isoelectric curve $a\,b$; and $a'\,a\,b\,b'\,a'$ will represent the cycle of operations gone through by the performance of work and a return to the condition of an idle battery.

In fig. 2 $a = \mathrm{R}\frac{ds}{d\mathrm{R}}$. In thermo-dynamics a represents the elasticity of a gas whose volume is represented by the line R. In electro-dynamics a may be taken to represent the capacity of a circuit, of given resistance, for work.

The area of the figure $a\,b\,b'\,a'$ represents the work accomplished in going through the cycle of operations $a\,b\,b'\,a'\,a$. As in thermo-dynamics we shall have $\mathrm{Q}'-\mathrm{Q}=\mathrm{A\,F}$, where F represents the area $a\,b\,b'\,a'$ and Q and Q′ the distribution of tensions. When the area F becomes infinitely small we have $d\,\mathrm{Q}=\mathrm{A}\,d\,\mathrm{F}$, and by a discussion of this area in reference to a change from m to $d\,m$ it is found that $\frac{\mathrm{Q}}{m}=$ constant.

In an electric circuit if $\mathrm{T}-t$ represents the difference of potential at any two points, then we have $\mathrm{Heat}=\mathrm{Q}'\ (\mathrm{T}-t)$ or $\frac{\mathrm{Heat}}{\mathrm{T}-t}=\mathrm{Q}'=a$ constant for any one epoch, and m may be taken to represent $\mathrm{T}-t$. The remarkable fact that the efficiency of both the thermo-dynamic and electro-dynamic engine is expressed by the same function $\frac{a-b}{a}$ has already been noticed by Mr. J. P. Joule, Manchester Transactions, vol. x.

ART. XXI.—*Brief Contributions to Zoölogy, from the Museum of Yale College.* No. XXIII.—*Descriptions of New North American Myriopods;* by O. HARGER.

THE Museum has lately received a number of interesting Myriopods from various parts of the country, collected in part by the writer while traveling across the continent as a member of Prof. Marsh's Geological Expedition to the Rocky Mountains and Pacific Coast. Owing to the comparative neglect of this group by entomologists, a large proportion of these species are new, and in the following article a few of the most interesting and characteristic forms are described.

Lithobius pinetorum, sp. nov.

Ferruginous, head and sometimes a few of the anterior segments of deeper color. Cephalic segment polished, its posterior margin elevated. Ocelli on each side ten to fourteen. Antennæ polished, smooth, except a few scattered hairs near the base, segments gradually decreasing distally, but the terminal segment is usually elongated. Labium with a median groove, a few hairs about the dental lamina; teeth two on each side, acute and spreading; there is sometimes a third smaller external tooth on each side. Mandibles sparsely hairy. Alternate larger scuta polished, with the posterior and lateral margins elevated, except in the last two scuta, where the lateral margins only are elevated, emarginate behind, especially on the posterior segments. Excavations on the coxæ small, nearly circular. Length 15^{mm}.

This species resembles *L. paucidens* Wood, but is easily distinguished by its smaller size, less number of ocelli, and by the smooth and polished antennæ. It was collected in considerable abundance under the bark of decaying pine logs, by Prof. G. H. Collier and the writer, in the valley of the John Day river, Oregon, in October, 1871.

Geophilus gracilis, sp. nov.

Very light orange, head much darker, slender, small. Cephalic segment nearly quadrate. Antennæ hairy, filiform, joints short obconic. Mandibles unarmed. Scuto-episcutal sutures distinct posteriorly. Feet pilose, thirty-nine or forty-one pairs, occasionally forty, last pair thickened and elongated. Sterno-episternal sutures distinct. Body slightly hairy throughout. Length, 15^{mm}.

This species is not uncommon under stones and rubbish in moist places about New Haven.

Trichopetalum,* gen. nov.

Sterna not closely united with scuta; third and fifth joints of antennæ elongated; scuta furnished with bristles; no lateral pores; eyes present.

This genus belongs to the family *Lysiopetalidæ*, and is closely related to *Pseudotremia* of Cope (Proc. Am. Phil. Soc., vol. xi, p. 179, 1869). It differs from that genus in having no pores, instead of having the "annuli with two pores on each side of the median line." The species further differ from *P. cavernarum* and *P. Vudii* Cope in having seven only, instead of eight, joints in the antennæ. In this point they also differ from *Spirostrephon Copei* Packard, from the Mammoth Cave (Am.

* From θρίξ, a bristle, and πέταλον, a leaf or plate.

Naturalist, p. 748, Dec., 1871). It may be remarked that, in the descriptions above referred to, Prof. Cope, in stating the relative lengths of the joints of the antennæ in each of the two species, omits all mention of the 6th joint; and, in the same manner, Prof. Packard omits the second. Prof. Packard's figures also represent only seven joints in the antennæ. *Craspedosoma*, as defined and figured by Gervais (Aptères, vol. iv, p. 119, plate 45, fig. 5), has the sterna and scuta consolidated into a complete ring as in *Polydesmus* and *Iulus*, and therefore differs from this genus, as shown in plate II, fig. 4, by a character considered of family importance.*

Trichopetalum lunatum, sp. nov. Pl. II, figs. 1–4.

Dirty white, banded transversely and mottled with light brown anteriorly. Segments 28; males with 45, females with 46 pairs of legs. Head large, dilated laterally, covered with short, erect, bristly hairs. Eyes (fig. 2) of 10 ocelli, in a lunate group, convex toward the bases of the antennæ. Antennæ (fig. 2) pilose, seven-jointed; the joints measure, the first ·07^{mm}, second ·10^{mm}, third ·23^{mm}, fourth ·11^{mm}, fifth ·22^{mm}, sixth ·09^{mm}, seventh ·07^{mm}. First scutum semicircular, with the posterior margin slightly concave. Near the outer angles of this scutum are two small tubercles on each side, each bearing a stout bristle, and higher up a third tubercle on each side bears also a bristle. The remaining scuta (fig. 4) throughout are furnished with three bristles on each side, springing from tubercles, the two lower being approximate and situated on the upper surface of the short lateral processes, and the third higher up on the scutum. On a few of the posterior segments these bristles are in a transverse row, and on the last scutum, which is broad and truncate, the two inner ones are thickened at their bases. There is an impressed dorsal line. Legs slender, white, hairy, with the penultimate joint lengthened. The under side of the seventh segment of the male (fig. 3) is furnished anteriorly with a pair of appendages directed backward and curved upward; and posteriorly with a pair of cylindrical jointed organs, directed horizontally outward, tipped with a short bristle, and appearing like modified legs of the posterior subsegment. In crawling these organs have a motion similar to that of the basal joints of the adjacent legs. Length 6^{mm}.

This species is not uncommon under or among decaying leaves in moist woods about New Haven.

* Since the above was in type Prof. Cope, in an article on the Wyandotte Cave and its Fauna (Am. Naturalist, July, 1872, p. 414), has referred *Spirostrephon* (*Pseudotremia*) *Copei* Packard to a new genus *Scoterpes*, which he characterizes as destitute of eyes and lateral pores. Agreeing with Dr. Packard, he also doubts the validity of his own genus *Pseudotremia*, and refers *P. cavernarum* to *Spirostrephon*. The lateral pores of *P. Vudii* are thus left somewhat doubtful, and without actual examination it is impossible to decide whether or not it is congeneric with the species of *Trichopetalum*.

Trichopetalum glomeratum, sp. nov.

This species is somewhat larger than the preceding, but closely resembles it, except in the following points. The general color is somewhat darker. The eyes (pl. II, fig. 5) of 19 ocelli in a subtriangular patch. There are 31 segments, and the fifth joint of the antennæ (fig. 5) is much shorter than the third. These joints, except the first, measure: second, ·20^{mm}, third ·40^{mm}, fourth ·24^{mm}, fifth ·33^{mm}, sixth ·18^{mm}, seventh ·12^{mm}. Length of animal, 10^{mm}.

A single specimen of this species was collected by the writer in the valley of the John Day river, Oregon, in October, 1871.

Trichopetalum iuloides, sp. nov.

Animal with the aspect of an Iulus, being destitute of lateral processes. Light chestnut, with a dorsal yellow line, and along the sides nearly obsolete yellowish spots. Segments 30. Head somewhat dilated laterally, sparsely bristly, hairy. Eyes triangular. Antennæ (pl. II, fig. 6) sparsely hairy, filiform, seven-jointed, fifth joint longest. The joints measure respectively, first ·10^{mm}, second ·12^{mm}, third ·21^{mm}, fourth ·12^{mm}, fifth ·22^{mm}, sixth ·08^{mm}, seventh ·05^{mm}. First scutum nearly semi-circular, but with the lateral angles acute, furnished with a transverse row of six short bristles, as are the other scuta; these bristles are much stronger on the posterior segments, and on the anal segment two of them are thickened at their bases. Under a high power, the scuta are seen to be minutely wrinkled transversely across the back, and longitudinally along the sides. Legs hairy. Length 8^{mm}.

This species was collected under stones at Simmons' Harbor, on the north shore of Lake Superior, by Sidney I. Smith, Naturalist to the U. S. Lake Survey.

Iulus furcifer, sp. nov.

Dark chestnut brown, beautifully ornamented with a black dorsal line, a lateral row of black spots and transverse bright yellow bands, which are very narrow and interrupted across the back. Feet and under part of body much lighter; segments about 55. Eyes triangular, connected by an impressed line along the upper margin of a dark band, which is encroached upon below by yellowish spots. Antennæ filiform, pilose and nearly black at tip, last joint very short; scuta with impressed lines on the sides, and under a lens the surface of the back is seen to be covered with minute oblong pits; anal scutum not mucronate. Male organs (pl. II, fig. 7) of three pieces on each side directed backward, the outer (fig. 7, *a*) cylindrical and distally hairy on the inner side; within this is a much larger piece (fig. 7, *b*) in the form of an elongated narrow plate bent around a robust spine (fig. 7, *c*), which is the inner and at its base the

upper of the three pieces, and is unequally forked at the tip, where it is inclosed by the larger piece. Length 35mm.

This beautiful species was collected by Prof. G. H. Collier and the writer in the John Day valley, Oregon, in October, 1871.

Polydesmus armatus, sp. nov.

Color various shades of chestnut brown or sometimes olivaceous, with the lateral laminæ and tip of anal scutum yellow; a few of the posterior scuta are sometimes lighter colored than the others. The inferior border of the face, and the basal joints of the antennæ are yellow; distally the antennæ are much darker. The anal scutum is much prolonged into a truncated spine. The large male appendages (pl. II, fig. 8) are hairy at their base, and consist of two principal portions; the larger and inner (fig. 8, *a*) is cylindrical for the first third of its course, and directed downward, inward, and forward; it then becomes lamelliform, and sends inward and upward a much excavated process (fig. 8, *c*), distally a smaller and less excavated one (fig. 8, *d*), and is at this point contracted, but expands so as to terminate in a much bent plate. The other portion (fig. 8, *b*) is a long curved spine on a bristly cylindrical base, arising a little behind and outside of the former, and curving spirally around it, so that its attenuated tip is received in the excavated process. A small stout hooked spine (fig 8, *e*) is nearly concealed by the bristles that spring from the base of the larger spine. Length 28mm.

This species resembles *P. Haydenianus* Wood, but may be at once distinguished by the much produced anal scutum, and by the male organs. It was collected in the John Day valley, Oregon, by Prof. G. H. Collier and the writer, in October, 1871.

Yale College, New Haven, Conn., June 27, 1872.

EXPLANATION OF PLATE II.

Figure 1. *Trichopetalum lunatum*, female, magnified 15 diameters.

" 2. Antenna and right eye of the same, magnified 40 diameters.

" 3. Inferior view of seventh segment of male of the same, magnified 40 diameters.

" 4. Diagram of transverse section of segment of the same, magnified 30 diameters.

" 5. *Trichopetalum glomeratum.* Antenna and right eye, magnified 25 diameters.

" 6. *Trichopetalum iuloides.* Antenna, magnified 25 diameters.

" 7. *Iulus furcifer.* Male appendages of left side, magnified 20 diameters, seen from above; *a*, outer cylindrical process; *b*, bent plate; *c*, inner forked process. The distal portion of this process being concealed by the bent plate, the corresponding process on the right side is figured in position.

" 8. *Polydesmus armatus.* Male appendages of left side magnified 20 diameters, seen from below; *a*, larger process; *b*, spine-like process; *c* and *d*, processes from the upper surface of *a*; *e*, curved basal spine.

Art. XXII.—*Preliminary Description of New Tertiary Mammals;* by O. C. Marsh. Part I.

The explorations of the Yale College party in the Rocky Mountain region, during the past season, brought to light, in addition to the extinct Birds and Reptiles already described by the writer, many interesting species of new fossil Mammals, and in the present communication a number of these from Wyoming Territory are briefly characterized. Others will be noticed in the succeeding numbers of this Journal, and it is intended, at an early day, to give a full description with illustrations of all the new fossil vertebrates discovered by the two Yale expeditions of 1870 and 1871.

Palæosyops laticeps, sp. nov.

An examination of the large collection of mammalian remains from near Fort Bridger, Wyoming, now in the Yale Museum, shows clearly that there are at least four well-marked species of large pachyderms represented, which have hitherto been referred to *Palæosyops paludosus* Leidy. This species was established on a number of teeth, more or less imperfect, which were all strongly rugose, although evidently belonging to an adult animal. Unfortunately no other portions of this skeleton were secured, so that it may be difficult if not impossible to determine with certainty its exact specific relations.

One of the treasures obtained by the Yale expedition of 1870, which first explored the Green River Tertiary basin, was the nearly complete skeleton of a species of *Palæosyops*, somewhat smaller than the one described by Dr. Leidy. The animal was adult, with the dental series in full perfection, although the epiphyses were not completely coössified with the vertebræ. The teeth in this specimen have apparently the same general structure as those in the type of *P. paludosus*, but differ in being nearly smooth; and this is not the result of age, as this individual was younger than the original of the larger species. The proportions, moreover, given for the molar described* ("22 lines fore-and-aft and 18 transversely"), would not apply to any of the series in the present specimen. The last upper molar of the latter has two well developed internal cones.

The cranium in *Palæosyops laticeps* is broad, and the zygomatic arches much expanded. The squamosal portion is especially massive. The nasals are narrow and elongated, and more like the corresponding bones in *Hyrax* than those in the larger pachyderms. They are prominently convex transversely, and strongly arched longitudinally. The inner edges are thickened

* Proceedings Philadelphia Academy, 1870, p. 113.

below at the suture, indicating a strong cartilaginous nasal septum. The anterior extremities are truncated, with the external angles rounded. The upper teeth form a complete series. The canine is large, and broadly oval at its base. The outer incisor is the largest, and at its posterior edge the premaxillary is subtriangular in transverse section. The sagittal and occipital crests are strongly developed, and the coronoid process of the lower jaw is short and recurved. The remaining portion of the skeleton, which will be described in detail in the full description, shows conclusively that *Palæosyops* belongs to the Perissodactyls, and not to the Artiodactyl group of mammalia, as supposed by Dr. Leidy.

Measurements.

	mm.
Length of entire upper molar series,	155·
Antero-posterior extent of three true upper molars,	94·
Antero-posterior diameter of last upper molar,	36·
Transverse diameter,	40·
Antero-posterior diameter of upper canine at base,	29·
Transverse diameter,	22·
Space occupied by three right upper incisors,	34·
Vertical extent of zygomatic process of squamosal,	51·
Transverse diameter of both nasals near anterior margin,	42·
Width between bases of upper canines,	49·
Width between bases of fourth upper premolars,	40·

This unique specimen was discovered in September, 1870, by Mr. A. H. Ewing of the Yale exploring party. The locality was near Marsh's Fork, about fifteen miles from Fort Bridger, Wyoming. The geological horizon was Eocene, or lower Miocene. Other specimens of the same species have since been found in the same region by members of both the expeditions.

Telmatherium validus, gen. et sp. nov.

A new genus of large mammals, allied to *Palæosyops*, is indicated by the greater portion of a skull with teeth, and portions of several other skeletons, obtained by the Yale party last year in the Tertiary deposits of the Green River basin. The dentition of this genus, so far as known, appears to be similar to that of *Palæosyops;* but the two may readily be distinguished by the anterior portion of the skull, which in the present genus has the premaxillaries compressed, with an elongated median suture. The zygomatic arch is also much less strongly developed, and the squamosal portion of it is comparatively slender.

The present species exceeded in size *Palæosyops paludosus*, and with the exception of *Titanotherium? anceps* Marsh,* is

* This Journal, vol. ii, July, 1871, p. 35. Additional remains of this animal, obtained during our explorations last year, show clearly that it belongs to the Proboscidea, as at first suspected. The species may therefore be called *Mastodon anceps*.

the largest mammal yet discovered in the Fort Bridger beds. The upper molar teeth have the inner cones more elevated and more pointed than in *Palæosyops*, and the basal ridge is well developed. The last upper molar has but a single internal cone. The upper canines are large, pointed, and have strong cutting edges. The outer incisors are the largest, and all these teeth have a strong inner basal ridge. The roof of the mouth is deeply excavated between the premolars. The nasals are decurved laterally, and much compressed.

Measurements.

Extent of upper molar series,	224·	mm.
Extent of upper true molars,	130·	
Antero-posterior diameter of last upper molar,	54·	
Antero-posterior diameter of last upper premolar,	28·	
Transverse diameter,	33·	
Space occupied by three right incisors,	47·5	
Antero-posterior diameter of upper canine at base,	27·	
Transverse diameter,	22·	
Vertical diameter of zygomatic process of squamosal,	34·	

The specimen on which this description is mainly based was discovered in September last by Mr. J. F. Quigley of the Yale party. The locality was near Henry's Fork of the Green River, in Wyoming, and the geological formation the same essentially as that near Fort Bridger, which contained the previous species.

Limnohyus robustus, gen. et sp. nov.

Among the other remains of large mammals in the Yale Museum, which resemble *Palæosyops paludosus*, in their dentition at least, are portions of several skeletons with the more important parts well preserved. These remains show conclusively that there are two genera represented among them. One of these is doubtless *Palæosyops*, but the type of that genus is too imperfectly known to determine its more important characters. These two genera agree apparently in the structure of the anterior portion of the skull, but differ somewhat in their dentition. In some specimens, which agree best with Dr. Leidy's original description of *Palæosyops paludosus*, the last upper molar has two inner cones, and to this group the name *Palæosyops* may in future be restricted. The other specimens have but a single internal cone on the last upper molar, and for the genus thus represented the name *Limnohyus* is proposed. These genera may be distinguished from *Telmatherium* by the premaxillaries, which are short, stout and depressed, with a small median suture. Other distinctive characters of the three genera will be given in the full description.

The present species may be distinguished from those above described, especially by the strong basal ridge of the molars.

On the last lower molar it extends entirely around the posterior lobe. The first of the upper true molars has the two inner cones nearly of the same size. The small intermediate median tubercles are well developed on the upper molars, and all the teeth are strongly rugose, even in fully adult animals. The nasal bones contract anteriorly and are rounded in front. The outer margin is decurved and thickened. The premaxillaries unite by a very short median suture, similar to that in *Palæosyops laticeps*. The zygomatic process of the squamosal is stout, but much compressed, thus differing widely from both the species already described.

Measurements.

	mm.
Antero-posterior extent of last three upper molars,	110·
Antero-posterior diameter of last upper molar,	41·
Transverse diameter,	43·5
Antero-posterior diameter of last upper premolar,	20·
Transverse diameter,	26·5
Antero-posterior diameter of last lower molar,	51·
Vertical diameter of zygomatic process of squamosal,	34·

The specimen on which the above description is chiefly based was discovered, in September last, by Mr. F. Mead, Jr., near Henry's Fork, Wyoming. Other specimens of the same species were found in the same deposits by Mr. G. G. Lobdell, Jr., Mr. G. M. Keasbey, Mr. O. Harger, and the writer. The geological formation was lower Miocene, or Eocene.

Hyrachyus princeps, sp. nov.

This well-marked species includes the largest of the Tapiridæ yet found in this country. The remains representing it indicate an animal nearly three times the bulk of *Lophiodon Bairdianus* Marsh, and probably twice that of the individual named *Hyrachyus eximius* by Dr. Leidy. The specimens on which the species is based consist of a nearly complete series of upper teeth, and several lower molars, with the more important parts of the skeleton, all pertaining to one animal, and remarkably well preserved. The last two upper molars are unusually large in proportion to the rest of the series, and have the antero-external lobe quite separate, and with its apex incurved.

Measurements.

	mm.
Extent of entire upper molar series,	134·
Extent of upper true molar series,	76·
Antero-posterior diameter of last upper molar,	21·2
Transverse diameter,	31·
Antero-posterior diameter of penultimate lower molar,	28·75
Transverse diameter,	17·

The remains here described were found by the writer, last autumn, near Henry's Fork, Wyoming, in the same Tertiary deposits that yielded the specimens already noticed.

Homacodon vagans, gen. et sp. nov.

A new and very small suilline pachyderm is well represented by the greater part of the skull and skeleton, in excellent preservation. The animal was apparently allied to *Hyopsodus*, and was somewhat larger than *H. paulus*. From that species, it may readily be distinguished by the lower true molars, which have the constituent cones isolated, not alternate, and of nearly equal size. The inner anterior cone is, however, somewhat the largest, and is slightly bifid. The upper molars, likewise, have their cusps conical, and of similar size. The lower premolars are compressed, and resemble those of some carnivors. The skull has a well developed sagittal crest. The astragalus is of the suilline type.

Measurements.

	mm.
Antero-posterior extent of the three lower true molars,	17·5
Antero-posterior diameter of last lower molar,	7·3
Transverse diameter in front,	4·
Antero-posterior extent of three upper molars,	15·2
Antero-posterior diameter of last upper molar,	5·5
Transverse diameter in front,	6·4
Length of astragalus,	14·

This very perfect specimen was discovered, in September last, by Mr. G. G. Lobdell, Jr., of the Yale party, near Henry's Fork, Wyoming, in the *Mauvaises terres* Tertiary deposits of that region.

Limnocyon verus, gen. et sp. nov.

An interesting new carnivor, somewhat larger than a fox, is indicated by the remains of several individuals, which agree closely in all respects excepting size. One series of these remains includes the greater portion of a skull with most of the upper teeth well preserved. The premolars in this specimen are compressed and obtuse, as in the Canidæ. The first upper premolar is large, and near the canine. There are no true sectorial teeth. The crowns of the first and second upper molars are triangular. The first has a tubercle at each angle, and a large compressed one near the center. The second molar, which is the largest of the series, has an angular tubercle at each corner, and a large bifid cusp near the middle of the crown. The last upper molar is very narrow and elongated transversely. Its straight anterior margin is at right angles to the axis of the skull. The affinities of this genus appear to be with the Viverridæ

Measurements.

Extent of last three upper molars,	23·	mm.
Antero-posterior diameter of first upper true molar,	9·6	
Transverse diameter,	8·8	
Antero-posterior diameter of penultimate upper molar,	10·75	
Transverse diameter,	11·	
Antero-posterior diameter of last upper molar,	4·5	
Transverse diameter,	12·5	

The specimens on which this species is established were discovered at Grizzly Buttes, near Fort Bridger, in September last, by Mr. J. F. Quigley and the writer.

Viverravus gracilis, gen. et sp. nov.

A much smaller carnivor, about the size of the common mink, is represented in our collections by two lower jaws with teeth, and a sectorial upper molar of one individual, and portions apparently of several others. The lower jaws in this genus are long, very slender, and compressed; the last two lower molars are tubercular. Both have the posterior part of the crown quite low, and the anterior half elevated, and composed of three angular cusps. The four teeth anterior to these are much compressed. The upper flesh tooth closely resembles that in some of the Viverridæ, and the genus should probably be referred to that group.

Measurements.

Extent of pre-molar and molar series of lower jaw,	28·	mm.
Extent of last three lower teeth,	15·	
Antero-posterior diameter of last lower molar,	4·5	
Greatest transverse diameter,	2·5	
Antero-posterior diameter of penultimate lower tooth,	5·2	
Greatest transverse diameter,	3·4	
Antero-posterior diameter of upper sectorial molar,	7·	

The type specimen of this species was discovered at Grizzly Buttes, Wyoming, last autumn, by G. G. Lobdell, Jr., of the Yale party.

Nyctitherium velox, gen. et sp. nov.

One of the most interesting discoveries of the last Yale expedition in the Tertiary of Wyoming, was the remains of a species of bat, which is of special importance, as no fossil specimen of Cheiroptera has hitherto been detected in this country. The most characteristic specimen obtained is part of a lower jaw, with the last three molars in perfect preservation. This fragment indicates an animal about the size of *Scotophilus fuscus*, and the teeth resemble those in that genus, but are not so wide. They have a distinct basal ridge externally. The jaw below the teeth is much compressed, and its lower border slightly convex longitudinally.

Measurements.

Antero-posterior extent of last three molars,	5· mm.
Antero-posterior diameter of last lower molar,	1·75
Transverse diameter,	1·
Antero-posterior diameter of penultimate lower molar,	1·85
Transverse diameter,	1·1
Depth of jaw below last molar,	2·

The remains on which this species is based were found by the writer, in September last, near Henry's Fork, Wyoming. The formation is Eocene, or lower Miocene.

Nyctitherium priscus, sp. nov.

A somewhat larger species, apparently of the same genus, is indicated by part of a lower jaw, with the penultimate molar perfect. The jaw is less compressed, and the tooth proportionally larger than in the above species. There is no external basal ridge.

Measurements.

Antero-posterior extent of last three lower molars,	5·5 mm.
Antero-posterior diameter of penultimate lower molar,	2·
Transverse diameter,	1·5
Depth of lower jaw below last molar,	2.5

This interesting specimen was found by Mr. G. G. Lobdell, Jr., last autumn, at the same locality as the preceding species.

Talpavus nitidus, gen. et sp. nov.

A very small insectivor, apparently allied to the moles, is well represented by several fragments of lower jaws with teeth, and probably by some isolated upper molars. Two characteristic specimens of these remains were found together, and doubtless belonged to the same animal, which was about the size of a mouse. One of these is part of a lower jaw, containing the first and second true molars; the other is an anterior portion with only the last premolar in position. The lower molars resemble externally those of *Talpa*, but on the inner side are more like those of *Scalops:* they have no external basal ridge. The lower jaws are more slender and compressed than those in most recent insectivors. The last premolar is compressed and pointed.

Measurements.

Antero-posterior extent of first two lower molars,	2·9 mm.
Antero-posterior diameter of penultimate lower molar,	1·5
Depth of jaw below penultimate molar,	2·
Depth of jaw below last lower pre-molar,	2·

The type specimen of this species was found by the writer, in September last, near Henry's Fork, Wyoming.

Yale College, New Haven, July 18, 1872.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *An experiment in reference to the question as to Vapor-vesicles;* by T. Plateau.—From a research of M. Duprez,* it is known that when a vessel of water is inverted with the opening downward, it is not necessary that this opening be very narrow for the water to remain suspended. M. Duprez kept water suspended in a vertical tube which was nearly 20 millimeters in internal diameter.

Assuming now that when water is hanging in such a tube with the surface downward a small hollow air-bubble is brought into contact with this surface, the air in it, in virtue of the pressure of the envelope, will immediately penetrate into the interior of the liquid, and will rise in it in virtue of the smaller specific gravity. This I have confirmed by means of an experiment. I took a small glass tube of about 4 millims. diameter in the clear, drew it out at one end to an aperture of about 0·4 millim. diameter, and closed the wider end by a cork coated with grease. By touching the drawn-out end with a piece of filtering paper, which was soaked with distilled water, I succeeded in bringing into the narrow aperture a column of this liquid not more than a millimeter in length. By carefully depressing the cork, a hollow bubble is seen to form at the drawn-out aperture, which may have a diameter of less than a millimeter, and usually lasts seven or eight seconds. In this operation the wider part of the tube must be covered with several layers of a non-conducting material in order to eliminate the influence of the warmth of the fingers. After having thus acquired the power of procuring very small hollow bubbles, water was suspended in a tube kept vertical by a suitable stand. The internal diameter of this tube was only a centimeter; and with such a small diameter the suspension is very easy. It is only necessary, after filling the tube with water and closing the mouth with a piece of paper, to invert it and then draw the paper aside to get a free surface; a hollow water bubble of less than a millimeter diameter is then produced as described above, and brought to the free surface of the suspended water. When they are in contact, the bubble detaches itself from the drawn-out tube; the air contained in it penetrates and ascends in the liquid. The experiment, repeated several times, always gave the same result.

Let us now assume that at a certain distance below the surface of the suspended water there is a current of visible aqueous vapor; if this vapor consists of vesicles, each of them, on coming into contact with the surface, will introduce a microscopic air-bubble into the water, which will immediately ascend in it; and the whole of

* "Mém. sur un cas particulier de l'équilibre des liquides," Mém. de l'Académie Roy. de Belgique, vol. xxvi, 1851, and xxviii, 1854.

these vesicles will form a cloud in the water of the tube, which slowly rises and destroys the transparency.

M. Duprez was good enough to make the experiment at my request. The water was suspended in a glass tube of 13 millims. internal diameter. A small metal vessel with an aperture of several centimeters diameter and containing a certain quantity of water, was placed under the free surface of the water of the tube over a lamp; the mouth of this vessel was about 12 centims. from the surface. A continuous boiling was thus obtained, and a current of visible vapor which rose to the surface of the suspended water; but though the experiment lasted more than half an hour, no cloud was observed in the water of the tube. The vapor condensed on the outside of the tube, and from time to time was wiped away; but the water inside retained all its transparency.

After this it seems difficult to retain any doubt as to the non-existence of the vesicular state. It seems to me, in fact, that only three objections could here be raised. It might either be said that the air-bubbles on penetrating into the water, from their unusual smallness and the very considerable capillary pressure which they have to support from the liquid, dissolve in the liquid, or that all vesicles burst on reaching the surface of the water, or that they roll along the surface of this liquid, separated from it by a thin layer of air or vapor, until they reach the outside edge of the tube to escape thence into the atmosphere.

But the first of these assumptions must be rejected; for the water had previously been shaken with air so long as to be completely saturated, and, secondly, while it was exposed to the action of vapor it must have lost whatever solvent power it possessed; and, moreover, sometimes even comparatively large air-bubbles appear on the upper part of the inside of the tube, where the hotter part of the water ascends.

The second supposition, though not quite inadmissible, is at any rate not very probable. We have seen that our small bubbles, measuring less than a millimeter, do not burst on coming into contact with the surface of water; why should it be otherwise with the vesicles? It may, perhaps, be urged that their envelope is far thinner than that of our small bubbles. But if vesicles exist, their envelope must be so thick that they are colorless; otherwise a cloud irradiated by the sun could have no bright luster; moreover, from the long duration of large clouds, they must be very permanent.

As regards the third supposition, is it probable that all vesicles could roll along the surface without touching? Moreover M. Duprez has repeated the experiment in such a manner that this surface was concave and remained so in spite of the fact that the volume of water increased owing to expansion by heat and the condensation of vapor; but now in this case a large number of vesicles should have rolled toward the apex of the concavity, have accumulated there, and therefore must soon have placed themselves in contact with the fluid surface: but nothing in the result was different; no cloud disturbed the transparency of the water.

I consider the above experiment, though not decisive, yet a very powerful argument against the hypothesis of the vesicular condition.

May I here be permitted to recall another experiment, which I have described in the eighth series of my investigation *Sur les figures d'équilibre d'une masse liquide sans pésanteur.* One of the chief objections which have been raised against the vesicular condition is, that the air contained in a vesicle would be exposed on the part of the fluid envelope to a considerable pressure, the effect of which would be that this air would gradually dissolve in the envelope, and would traverse it, by which the vesicle would soon change into a complete globule. But when a laminar calotte, about a centimeter in diameter, is formed by means of a solution of 1 part of Marseilles soap in 40 of water, and this is allowed to stand in an atmosphere laden with aqueous vapor, it sometimes lasts for more than twenty-four hours and becomes quite black. At the same time a remarkable phenomenon is witnessed; the calotte gradually decreases and ultimately disappears,—from which it follows that the enclosed air has gradually traversed the lamina. This lamina is indeed far thinner than a vesicle would be; but, on the other hand, theory shows, from the difference of the liquids and the diameter, that in the interior of a vesicle the pressure would be more than a thousand times as great as in the interior of a calotte of soap-solution at its original dimensions.—*Bull. Acad. Belgique*, vol. xxxii.—*Phil. Mag.*, IV, xliii, 316.

2. *On the nitro-compounds of the fatty series.*—By the action of ethylic iodide upon argentic nitrite, MEYER and STÜBER have obtained a new substance isomeric with ethylic nitrite. When ethylic iodide is poured upon argentic nitrite, violent ebullition ensues. To complete the reaction, the mixture may be heated for some hours with a reversed condenser. On distillation, a mixture of ethylic iodide and nitrite passes over at first; afterward the new substance, which boils at 111°–113° C. The authors give this body the name of nitro-ethan. It is a perfectly colorless, clear liquid, of a peculiar agreeable, etherial odor. Its density at 13° C. is 1·0582 (taken with reference to water at the same temperature); it is insoluble in water, does not explode on heating, and burns with a pale flame. Analysis and a determination of the vapor density gave the formula $\mathrm{C_2H_5NO_2}$, which is also that of ethylic nitrite, the boiling point of which is 96° C. lower. When nitro-ethan is heated with iron filings and acetic acid, a violent reaction ensues, which must be moderated by plunging the flask into cold water so that the liquid does not boil. On subsequent distillation with caustic potash, ethylamin passes over in large quantity, and in a state of great purity. Hence it appears that nitro-ethan corresponds to the aromatic nitro-compounds. The relation between this body and ethylic nitrite may be expressed by the formulas:

$\mathrm{C_2H_5-O-NO}$. Ethylic nitrite (B. p. 16° C.).

$\mathrm{O_2N-C_2H_5}$. Nitro-ethan (B. p. 111°–113° C.).

A solution of caustic potash dissolves nitro-ethan, which appears to possess weak acid properties. Sodium attacks it with evolution of gas and formation of a white powder, which explodes on heating. The authors promise a further investigation of this very interesting subject.—*Berichte der Deutschen Chem. Gesell., Jahrgang* v, p. 399. W. G.

[*Note.* Is it not possible that in the extraordinarily stable double salts of cobalt, iridium and rhodium, having respectively the formulas, $Co_2(N\Theta_2)_{12}K_6$, $Ir_2(N\Theta_2)_{12}K_6$, and $Rh_2(N\Theta_2)_{12}K_6$, the nitrous atom is (Θ_2N-) and not $(-\Theta-N\Theta)$? W. G.]

3. *On the reduction of glutanic acid by iodhydric acid.*—The researches of Ritthausen have rendered it probable that glutanic acid is one of the homologues of malic acid containing C_5 in the molecule. Dittmar has given the subject a careful study, and has arrived at the following results: Glutamic acid was first prepared by the action of sulphuric acid upon pure conglutin. The pure glutamic acid, $C_5H_9N\Theta_4$, was then converted into glutanic acid by the action of nitrous acid. The glutanic acid obtained in this manner, $C_5H_8\Theta_5$, was then heated in a sealed tube with a saturated solution of iodhydric acid, by which it was converted into desoxy-glutanic acid, $C_5H_8\Theta_4$. The new acid is bibasic, forms large crystals which belong to the monoclinic system, and is easily soluble in water. The formula of this acid is the same as that of pyrotartaric acid, with which it is not, however, identical. From this it appears that glutanic acid is not identical with either of the three homo-malic acids derived from aconitic acid, since all of them yield pyrotartaric acid by reduction.—*Journal für prakt. Chemie, Neue Folge*, Band 5, p. 338. W. G.

4. *On an aldehyd-alcohol.*—Wurtz has obtained a new polymer of aldehyd, having the formula $C_4H_8\Theta_2$, to which he gives the name of aldol. It is a perfectly colorless liquid, which after cooling becomes thick like a pure solution of sugar. It is so viscid at 0° that the tube containing it may be inverted without any flow of liquid. When gently heated, it becomes as fluid as water, but it regains its viscid character only some hours after cooling. Its density at 0° is 1·1208: it has a strong aromatic and bitter taste, and mixes in all proportions with water and alcohol. When heated to 135°, aldol is resolved into crotonic aldehyd and water:

$$C_4H_8\Theta_2 = C_4H_6\Theta + \Theta H_2.$$

Aldol reduces argentic nitrate and cupropotassic sulphate. When heated for some days with anhydrous acetic acid, aldol forms an acetate having the formula $C_4H_7\Theta(C_2H_3\Theta_2)$; and a diacetate having the formula $C_4H_6(C_2H_3\Theta_2)_2$, which may be regarded as the diacetate of crotonic aldehyd. Nitric acid oxidizes aldol with great energy, forming several organic acids not yet described. Phosphoric chloride also acts energetically upon aldol, forming a chloride which is probably $C_4H_7Cl_2$. This is a thick, colorless liquid almost impossible to purify. Wurtz considers aldol to have a constitution represented by the formula:

$$CH_3-CH(\Theta H)-CH_2-CH\Theta.$$

By the prolonged action of chlorhydric acid upon aldehyd, Wurtz obtained also the anhydride of aldol $(C_4H_7O)_2O$. The author remarks that aldol in many respects resembles the sugars, glucose being like aldol, at the same time an aldehyd and an alcohol.—*Comptes Rendus*, Tome lxxiv, p. 1361. W. G.

II. Geology and Mineralogy.

1. *Fossils probably of the Chazy era in the Eolian Limestone of West Rutland;* by E. Billings. (From a letter to J. D. Dana, dated Montreal, May 23.)—I received last summer some fossils from Rev. A. Wing, and made the following note upon them before I sent them back.

15th June, 1871, from the Rev. A. Wing, twenty specimens with the following ticket:

"Encrinites and obscure fossils, supposed to be Trenton, collected May, 1870, at the marble quarries, West Rutland, not one hundred yards northwest of an abandoned marble quarry,—the most northern one worked on the southwest side of the valley, say one hundred and fifty rods southwest from Barns' hotel, West Rutland."

This is the description of the locality given by Mr. Wing. My note on the fossils in the book I keep for such purposes is—

"These consist of numerous obscurely preserved forms like *Pleurotomaria staminea*, small encrinal joints, and a single plate of *Palæocystites tenuiradiatus*. I think this collection is Chazy. The rock is a gray fragile limestone with white crystalline seams in it."

If Hitchcock's Eolian is Stockbridge limestone, then the latter includes the Chazy. The plate of the Cystidean, *P. tenuiradiatus* Hall, is a never-failing guide to the Chazy; at least it is so on the west side of Lake Champlain.

2. *Hayden Exploring Expedition. On the Discovery of the Quebec formation in the Territory of Idaho;* by Prof. F. H. Bradley, Geologist of the Expedition. (From a letter to J. D. Dana, dated Fort Hall, Idaho, July 7th, 1872.)—I write to announce the discovery of the Quebec group. I first found it in the mountains on the east side of Malade valley, about six miles south of Malade City. It is here full of trilobites, with some gasteropods and brachiopods. It is at least 1,000 feet thick, and probably much more than that. (I hope to work out the details as we pass southward, in October.) The limestone is underlaid by a compact ferruginous quartzite, which, from its position, may be considered as representing the Potsdam sandstone. I traced the bed, nearly continuously, to the angle of Port Neuf Cañon—a distance of over fifty miles. At this latter point the bed seems to thin somewhat, and is overlaid by 1,000 feet or more of quartzites.

I am hoping to get again upon this group as we pass northeastward to the Tetons.

3. *La Nêvé de Justedal et ses Glaciers ;* par C. DE SEUE, adjoint à l'Institut Météorologique de l'Université Royale de Christiania. 56 pp. 4to, with a chart, 9 photographs, and a lithographic plate. Christiania, 1870.—We cite here a few facts from this important memoir. The great névé of Justedal covers a high plateau, lying between Sogn on one side and the Nordfiord and Söndfiord on the other, having a height of 1400 to 1650 meters above the sea, but passing northeastward into a chain of mountains, the culminating summits of which are the Lodalskaobe, 2076 meters in height, St. Cæciliekronen in the Olden, 1950 meters, Suphellenipa, near the middle of the névé, 1720 meters, and Gottop-hesten, to the west of the valley of Vetlefiord, 1710 meters in height. The névé, or uninterrupted snowfield, takes its origin northeast of Lodalskaobe, and terminates to the southeast by the Skarvedalsbræ, where it descends the valley of Viksdalen into the Söndfiord. The length of the *nêvé* region is thus about 42 miles, and its surface over nine hundred square miles.

The glaciers of the first class that descend from the snow-plateau are those of—1, Vetelfiord; 2, Boium; 3 and 4, Suphelle; 5, Langedal; 6. 7, Optag; 8, Austerdal; 9, Tunsbergdal; 10, 11, 12, Bergset; 13, Nigar; 14, Faobergstol; 15, Lodal; 16, Stegeholt; 17, Gredung; 18, Bödal; 19, Nesdal; 20, Aobrække; 21, Brigsdal; 22, Melkevold; 23, Fond, in the valley of Stardal; 24, Lunde. After numerous measurements of the rate of progress in the movement of the ice in the glaciers of Boium, of Tunsbergdal, and of Lodal, in the course of the month of August, the author gives the following as the mean results.

In the case of the glacier of Boium, the rate per hour near its extremity was 0·28 in. (Norwegian and English); 3,000 feet above the extremity it was 0·66 in. 108 yards from the less convex side, 0·87 in. at the middle, and 0·81 about 100 yards from the opposite or more convex side; while at points along the less convex side within 20 to 40 yards of the margin the rate was 0·16 in. to 0·20 in. an hour.

For the glacier of Tunsbergdal, the rate per hour near the extremity was 0·23 in.; about 2,900 feet above it was 0·37 in. 135 yards from the concave side; about the middle 0·41 in. to 0·51 in.; and toward the convex side 0·62 in. to 0·63 in.

For the glacier of Lodal, the rate per hour, about 490 yards above the extremity, was at the middle 0·104 in. to 0·091; about 1,875 yards above the extremity 0·183 in., 0·218 in. and 0·212 in.; about 2,500 yards from the extremity, just below where the two great tributary glaciers come in from the right and left, 0·047 in. near the margin; 100 yards from this margin, 0·140 in.; about the middle of the glacier 0·279 in. to 0·297 in.

The author states that the inclination of the surface beneath the glacier where the measurements were made is about the same for each, and that the difference in the rate of motion depended on the pressure from the upper part of the glacier. This pressure was, therefore, much the greatest for the glacier of Boium. The

conclusions are drawn that the movement diminishes in ratio toward the sides, bottom, and extremity of the glaciers; and when the course bends, so that one side is convex and the other concave, the movement is most rapid on the convex side.

These are only a few of the results brought out in this Memoir. It is illustrated by a map and diagrams, and also by a photographic plate made up of nine photographic views of the Norwegian glaciers.

4. *The Ancient Glacier of the Rhone.*—It is known that, at a former period, the glacier of the Rhone spread westward over lower Switzerland to the Juras, and lodged boulders on these mountains, and that Prof. Guyot followed the lines of these boulders from the Juras across the plain to their sources in the Alps. Messrs. Falson and Chantre have recently traced the path of this glacier all the way from Lake Geneva, southwestward to Lyons, passing by Seillon, Châtillon, Ars and Sattonay, and even ten miles farther south, to Vienne in Dauphiny. In its course, after being joined by the glacier of the Arve (of which the Mer de Glace was one of the sources), it encountered the local glaciers of some of the valleys of Bugey; but it ended in surmounting the latter and depositing its moraines of crystalline rocks over their moraines of limestone rocks.—*Bibl Univ.*, 1870, xxxviii, 118, and *Bull. Soc. Geol. de France*, 1869, xxvi, 360; from *Bibl. Univ.*, 1872, xliv, 46.

5. *Glacial action in Fuegia and Patagonia.* Abstract of a letter by Prof. Agassiz of the Hassler expedition, addressed to Prof. B. Peirce, dated Talcahuano, April 27.—In the straits of Magellan, passing Sandy Point, the first unquestionable *roches moutonnées* seen were on the nearest coast opposite Cape Froward. In Port Gallant large boulders were observed, some 6 feet across, one 12 × 6 × 5 feet, well polished and scratched. In Fortescue Bay there are similar scratched boulders; and also glacier scratches on the rocks, their trend W.N.W.; and glacial phenomena continue from this region to Jerome Point, which is itself well polished, especially on the south side. York River valley, which trends north, is well polished on both sides, and so also a gorge opposite, showing that the denudation was not due to an agent following the east-and-west course of the Magellan straits. The two heads of the narrowest part of the straits are beautifully polished and rounded. Similar glacial effects were observed in Borgia Bay; and Pourtales traced them up a peak to a height above the sea of about 1,500 feet. Glacier Bay and Sholl Bay were also very remarkable for their glacial phenomena. In Glacier Bay and other points there was evidence that the glacier once had a much greater extension than now.

Prof. Agassiz concluded from the character of the north and south sides of the summits in Fuegia, and other facts, that the movement of the ice was to the north, and independent mainly of the present slopes of the land.

The region over which Prof. Agassiz states that he observed glacial phenomena in southern South America includes all of the

continent south of 37° of S. latitude both on the Atlantic side (Bay of St. Matthias) and the Pacific side. At Talcahuano large erratic boulders and *roches moutonnées* were observed at the mouth of the Biobio, on the hills of Hualpen. In the Bay of San Vincente (between Concepcion Bay and the Bay of Aranco) glacial markings were found by Mr. Pourtales, at the sea level—"a magnificent polished surface," says Prof. Agassiz, "as well preserved as any I have seen under glaciers of the present day, with well-marked furrows and scratches;" and this is in latitude 37°. The place is only a few feet above tide level, upon the slope of a hill on which stand the ruins of a Spanish fort. The course of the scratches is nearly east and west; but some cross the main trend, and run southeast. The magnetic variation at Talcahuano is 18°3′, the true meridian being to the right of the magnetic.

6. *Annual Report of Prof. D. F. Boyd, Superintendent of the Louisiana State University, for the year* 1871, *to the Governor of the State of Louisiana.* 222 pp. 8vo. New Orleans, 1872.—This report, besides its interesting information on the condition, prospects, and needs of the Louisiana State University, contains also the Third Annual Report of the Botanical Survey of Southwest and Northwest Louisiana, made in 1871, by Prof. A. Featherman; and that of the

Geological Survey of the State by F. V. Hopkins, M.D., Prof. Geol., Chem. and Min., in the University.

In the Geological Report, Prof. Hopkins gives many important facts with regard to the Post-tertiary deposits, and also a colored geological map of the State. The Post-tertiary is stated to consist, following the order of age, of (1) the Drift, (2) the Port Hudson group (so named by Hilgard), (3) the Loess, (4) the Yellow Loam. To the last three the term *Bluff formation* is here applied; and it is stated that "the delta formed by the Mississippi from the end of the Drift period to the era of the Loess was composed of its strata."

The beds of the Port Hudson group are mostly hard sand-beds, sandy-clay and clay; they are more or less calcareous, and are often characterized by calcareous concretions. The thickness at the sulphur wells of Calcasieu is 160 to 282 feet. Prof. Hilgard made the thickness at New Orleans 650 feet; but Prof. Hopkins gives reasons for suspecting that part of this may belong to the proper loess. Sea shells of recent species are occasionally found in the southern part, and fresh water shells in some places. The deposits also afford bones of various Post-tertiary animals, including those of the *Megalonyx*. Lignite layers also occur in it, and sometimes contain stumps.

The loess is mostly a fine silt, little compacted. The water of slight rains is absorbed into its porous beds, while heavier flows wear the formation into deep channels having nearly vertical sides. It often contains land shells of the genera *Helix*, *Helicina*, *Pupa*, *Cyclostoma*, *Achatina*, and *Succinea*, as long since observed near Natchez by Lyell; and sometimes affords bones of the mastodon.

The yellow loam bed is for the most part between ten and twenty-five feet in thickness. "It is remarkable for the uniformity with which it appears at various levels, proving its deposition since the occurrence of a large amount of denudation in the older Bluff strata themselves."

Prof. Hopkins holds, we believe correctly, that the Port Hudson and the overlying beds were deposited when the land was at a lower level than now; and that the loess was the accumulation over an old flood plain of the Mississippi, as suggested by Lyell, —that the "lake-like expansion of fresh-water so widely spread over the interior [in which it was formed] being really that of an estuary connected with the Gulf," and not of a true lake confined by a supposed barrier.

The drift contains pebbles, which are mainly of reddish and yellowish chert. Among them there are numerous Silurian and Devonian fossils, with some from Carboniferous rocks; and more than a hundred species have been identified, and are included in a list on pages 191 to 195 of the report. Among these there are 12 species of Crinoids, 25 of corals, and over 40 of Brachiopods; they must have come from Tennessee and the States farther north either side of the Mississippi river; some of them from points 400 miles or more distant. The thickness of the drift in Louisiana is stated to average 200 feet. In the northwestern part of the State there are Azoic pebbles from Arkansas. "The drift beds are stratified more or less regularly, as if deposited in running water; they show unmistakably the action of running and not of quiet water." They contain rarely angular masses half as large as a man's head; and near Vicksburg blocks of even 500 lbs. weight have been observed; "and there is no doubt," says Prof. Hopkins, as also in substance, earlier, Prof. Hilgard, "that the passage of this formation into the modified drift of the North is easily demonstrable. The drift was transported by water, and must date from the period of depression, or melting of the glacier."

For the distribution of the drift Prof. Hopkins brings in the agency of icebergs in a sea at least 1,159 feet deep in the Ohio valley, drift-boulders of large size occurring at this elevation in Licking Co., Ohio; and on this point he adds; "We are here far within the Mississippi valley, and must grant that when the water floated an ice raft either up or over a hill 1,159 feet above the present sea-level there was a clear sweep for the polar current from the straits of Belle Isle (Gulf of Newfoundland) to the Gulf of Mexico."

This iceberg theory appears to be here called in just where it cannot serve. If the Gulf of Mexico had then opened up over the Continent either to the Arctic or the Gulf of Saint Lawrence, with the water 1,159 feet—or say 1,000 to 2,000 feet or more—deep at the Gulf, the Gulf stream would be the current, *if any*, that would have occupied the great interior sea of the Mississippi valley; and this would have given icebergs southward-bound a hard up-stream current to beat against. There does not appear to be any good foundation for the conclusion that the Labrador current would

have had control of the waters. The latter flow would have had by its position greatly the advantage of the former in the contest for possession of the Mississippi region, and would at least have nullified the Labrador flow if nothing more. The iceberg theory is therefore as wholly inapplicable to Louisiana as it is to New England. Besides the above consideration, and also the objection to a continental submergence in the absence of the skeletons of whales, shells, and other sea relics from the drift regions of the continental interior, there is other evidence against the iceberg theory in the fact that the deposits of sand bear evidence, in many places, as Prof. Hopkins says, that they were made by *running water* in rapid flow. The oceanic currents are slow lazy currents, even the best or largest of them; 3 miles an hour is an unusual rate, and 5 miles an extreme except in narrow channels. So slow a movement is wholly inadequate to produce the kind of beds making up much of the drift; for the sand deposits often bear evidence of the fling of the waves, or of the violent rush of a tidal current, as sketched by Prof. Hilgard in his Geological Report on the State of Mississippi. The deposits of this wave and tidal-current origin in the vicinity of New Haven bay (Connecticut), where it is certain the depth of water was small—not too great for effects from wave-action—are precisely identical with some of those of the stratified drift of the State of Mississippi figured and described by Professor Hilgard.

But, while the glacier may have brought the boulders of Licking Co., Ohio, to their present place, and been a prominent means of transportation over the north, icebergs, or in more commonplace language, *floating ice*, may still have had, during the opening Champlain era, a vast deal to do with the transportation of stones, pebbles, and sand in the region of the Great Lakes and along the Mississippi valley. The melting of the great glacier, "6,000 feet" thick to the north, would have gone forward for a long period with extreme slowness, even after the subsidence of the Champlain epoch had taken place. But sooner or later the flood from the melting would have begun; and, as Prof. Hilgard has shown, it would have been a vast flood, coming as it must have done from ice that buried deeply the whole breadth of the Mississippi water-shed, and even from regions beyond it, since one or more of the Great Lakes then poured their waters southward—an area hardly less than twenty millions of square miles. And, in such a flood, masses or bergs of ice, freighted with stones, would have gone with the current southward; while the waters in rapid violent flow would have transported the sands and even coarser material, and made deposits of all the various kinds observed.

J. D. D.

7. *Investigations on Fossil Birds;* by Mr. A. MILNE-EDWARDS.—At the moment when my investigations upon fossil birds approach their termination, and before the last part is given to the public, I will ask the Academy's permission to explain in a few words the results at which I have arrived during these studies, which have lasted fully twelve years.

I believe I have demonstrated, by the examination of the bones which have been found in the recent deposits in the Mascarene Islands, and which belong, for the most part, to extinct species, such as the dodo, the solitaire, the *Aphanapteryx*, *Fulica Newtoni*, large parrots, &c., that these islands have once been part of a vast extent of land, that these lands by little and little and by a slow depression have been hidden under the waters of the ocean, only leaving visible some of their highest points, such as the islands of Mauritius, Rodriguez, and Bourbon. These islands have served as a refuge for the last representatives of the terrestrial population of these ancient epochs; but the species, confined in too limited a space and exposed to all causes of destruction, have disappeared by degrees; and man has in some measure aided in their extinction.

Madagascar evidently was not in communication with these islands; for when Europeans visited them for the first time, they did not find there any Mammalia, with the exception of some large bats; none of those remarkable Lemuridæ peculiar to the fauna of Madagascar existed in the Mascarene Islands. The study of fossil birds leads to the same result; and the three species of *Æpyornis* which Mr. A. Grandidier and I have been able to recognize among the fossils collected in the swamps of the south-west coast have enabled us to establish the relationship which connects these birds with the *Dinornis*, the *Palapteryx*, and *Aptornis* of New Zealand. All these species belong to the same zoölogical type, and make us feel that at a more or less remote epoch there may have existed some communication between these lands so far away from one another; perhaps groups of islands, now submerged, formed intermediate stations, of which unfortunately we have now no trace.

In France, from the earliest age of man, we remark sometimes in superficial deposits, sometimes in caverns, fragments of birds which furnish us with valuable indications of the climatal conditions of that epoch. Some of these species have now entirely disappeared: others, in considerable numbers, have by degrees retired toward the north—for instance, the grouse and the great hawk owl, which then were extremely common in these countries. Their presence is most significant; for even supposing, according to some naturalists, the reindeer is only found fossil in France because it had been introduced by the Finnish population, we cannot invoke the same explanation for birds which have never been domesticated. Lastly, we also find in our caves a great number of species identical with those which now inhabit temperate Europe—among others, the cock, which was supposed to be a native of India, but which, on the contrary, must have been a contemporary of the first ages of man.

It is especially the Middle Tertiary deposits which have furnished me with a rich harvest. Thus in the Department of the Allier I have recognized the presence of about 70 species belonging to very various groups, some of which no longer belong to our

fauna. Parrots and trogons inhabited the woods; swallows built in the fissures of the rocks nests in all probability like those now found in certain parts of Asia and the Indian archipelago. A secretary bird nearly allied to that of the Cape of Good Hope sought in the plains the serpents and reptiles which at that time, as now, must have furnished its nourishment. Large adjutants, cranes, flamingoes, the *Palælodi* (birds of curious forms, partaking both of the characters of the flamingoes and ordinary Grallæ), and ibises frequented the banks of the water-courses where the larvæ of insects and mollusks abounded; pelicans floated in the midst of the lakes; and, lastly, sand-grouse and numerous gallinaceous birds assisted in giving to this ornithological population a physiognomy with which it is impossible not to be struck, and which recalls to one's mind the descriptions which Livingstone has given us of certain lakes of southern Africa.

The list I have given of the birds whose existence I have ascertained in the part of the Miocene lakes the alluvium of which has formed the deposits of St. Géraud le Puy, of Vaumas, &c., indicates the relations in which the different groups of this class of vertebrates lived. Whilst some of them are extremely common, there are others which are found, so to speak, only accidentally, and which are only represented in my collection by a single bone or only a few bones. The species most frequently met with are the water-birds: thus the ducks have left numerous remains; the cormorant is only found at certain places. Evidently at that time, as now, birds had preferences for certain places, certain rocks, &c., from which they departed but little. The little diver (*Colymboides minutus*) is less abundant than the gulls, of which two species, *Larus elegans* and *L. totanoides*, exist in profusion.

It is the same with some of the small shore-waders belonging to the genera *Totanus* and *Tringa*, whilst *Elorius* and *Himantopus* are represented by few individuals. I have found numerous bones of the ibis, and in particular of the *Palælodus ambiguus;* the four other species of the latter genus are by no means so common. Thus out of two hundred bones of these birds hardly one will turn out to be of *P. crassipes*, *P. minutus*, *P. gracilipes*, or *P. goliath.* The portions of the skeleton of the flamingo are rarely found entire at St. Géraud le Puy; whereas at Coumon and Chaptuzat, on the contrary, they are well preserved. I have only once met with the bones of the adjutant; they belonged to two young specimens, and were associated in the same excavation filled with sand. The cranes are rare; their bones are almost always broken and often injured by the teeth of rodents, as if they had lain for a long time on the bank before being carried to the bottom of the lake. The rails, the gallinaceous birds, the pigeons, the sand-grouse, the passerine birds, the raptores, and the parrots have left but few traces of their existence. These birds, from their mode of life, did not remain continually on the shores of the lakes or water-courses; their remains might be eaten or destroyed at once, and it would need a concurrence of exceptional circumstances for them to be

transported by the streams into the alluvial deposits of the lakes: thus I had explored these deposits for more than ten years before I met with a single bone of a parrot, sand-grouse, secretary bird, or of several of the raptores; and some, of which I had collected the remains a long time ago, have not appeared since.

All the bones of birds collected in the Miocene beds of Weissenau, in the basin of Mayence, that I have been able to examine, present a complete resemblance to those of the Department of the Allier.

The ornithological population of the celebrated deposit of Sansan, in the Department of the Gers, presents another character; not one of its representatives is found in the lacustrine deposits of the Bourbonnais and the Auvergne: and although the greater part of the species belong to families at present existing in our fauna, not one is known to be actually living, and several of them present characters sufficient to constitute new genera.

I have discovered there a parrot of a more slender form than that of the Allier, and I have designated it by the name of *Psittacus Lartetianus*, to attach the name of my regretted master and friend to one of the most interesting species that I have ever found in this rich deposit. Some gallinaceous birds of a large size, and in this respect hardly inferior to the peacocks and true pheasants, also inhabited the shores of the little lake, where the deposits accumulated which now form the hill of Sansan; numerous passerine birds, resembling the Bengalis and Senegalis, frequented the margins of the waters; lastly, the number of species was not less than 35, and certainly new excavations will not fail to make known more.

The marine faluns of the Loire have only furnished me with a few species of birds. I have been able, however, to recognize a cormorant almost as large as that which now lives on our shores, a goose a little smaller than the bernicle, a heron, and a pheasant.

The beds of gypsum in the environs of Paris contain numerous impressions of skeletons of birds; and it is to be observed that the animals of that period deviated more from the zoological forms which exist at the present day. Thus, despite the unwillingness I feel, especially in paleontological studies, to increase the already too large number of generic groups, I have been obliged to form new genera for many among them. Thus the *Cryptornis antiquus* was nearer the hornbills than any known type; *Laurillardia* and *Palægithalus* belong to the order of passerine birds, but were quite distinct from all those now living. The *Palæortyges* are gallinaceous, of the size of a quail, but very different from those birds. *Gypsornis* is the giant of the family Rallidæ; it must almost have attained the size of a stork. *Agnopterus* approaches the flamingoes, although it displays some peculiar characters.

The singularity of the forms of these Eocene birds makes us doubly regret not knowing those of the Cretaceous period. Unfortunately there exist only a very small number of freshwater deposits dating from that period; therefore it is not astonishing that

we have as yet discovered only very few traces of terrestrial animals which lived during the deposition of these important strata. Perhaps new zoological forms will be discovered there filling up the immense gap which exists between the Jurassic *Archæopteryx* and the typical birds of the Tertiary epoch.*—*Comptes Rendus*, April 15, 1872, pp. 1030–1034.—*Ann. Mag. Nat. Hist.*, IV, x, 72.

8. *Fossil Vertebrates from the Niobrara and Upper Missouri.*—Prof. Leidy has founded a species of lion, *Felis augustus*, on several teeth and fragments of jaws from the Loup Fork of the Niobrara, Nebraska, obtained by Dr. Hayden. The most characteristic specimen is an upper sectional molar about as large as that of the Bengal tiger. He has also described a vertebra from the base of the tail, belonging to an animal related to Plesiosaurus and Discosaurus; and "viewing the specimen as probably representing a genus different from those mentioned, he proposes for the species the name *Oligosimus grandævus*." Another specimen obtained by Dr. Hayden in the "Black Foot country" at the head of the Missouri, "looks as if it had formed part of the dermal armor of some huge saurian, or perhaps of an armadillo-like animal." Accompanying this specimen there is a distal phalanx, which may belong to the same species, named *Tylosteus ornatus.*—*Proc. Acad. Nat. Sci.*, April 2, 1872.

9. *Extinct Mammals from the Tertiary of Wyoming;* Prof. *Leidy.*—One specimen here described is a fragment of an upper jaw with two molar teeth, and another a lower jaw with one molar. The upper molars have crowns composed of four lobes, the outer of which are like those of *Anchitherium.* The three upper molars occupied a space of eight lines. They are too large for the known species of *Hyopsodus* or *Microsyops*, and nearly accord with the lower molars of *Notharctus.* The species is named *Hipposyus formosus.*

Dr. Leidy remarked that the tooth of *Anchippodus riparius* was obtained from the Tertiary, Miocene or Eocene, of Monmouth Co., N. J.; and if the determination is correct it would go to show that the Bridger Tertiary formation of Wyoming was cotemporaneous with the Tertiary deposit of Monmouth Co., N. J.—*Proc. Acad. Nat. Sci. Philad.*, Apr. 2, 1872, p. 37.

10. *Graptolites.*—Prof. Allman has a valuable article on the morphology and affinities of Graptolites in the May number of the Annals and Magazine of Natural History, which concludes as follows:

"Their alleged Polyzoal [or Bryozoan] affinities, however, have some claim on our acceptance. Indeed, were it not for the discovery of the probable graptolite gonosome (corbulæ?), we should have nearly as much to say for this view as for that which would refer them to the Hydroida, more especially as the discovery of *Rhabdopleura* renders us acquainted with a polyzoon in whose test

* On this point, see Marsh, this Journal III, iii, 56, 360.

is developed a chitinous rod in almost all respects like that of the graptolites.*

On the whole, then, it would seem that the graptolites constitute a very aberrant hydrozoal group having manifest affinity with the Hydroida, to which they are connected by the nematophore-bearing genera of the latter, while they have also important points of connexion with the Rhizopoda. The undoubted members of this group are further characterized in an eminent way by the possession of a solid supporting rod; and it is this feature which has suggested to me the name of RHABDOPHORA, by which I have proposed to designate them."

11. *Descriptions of New Species of Fossils, from the vicinity of Louisville, Ky.;* by JAMES HALL and R. P. WHITFIELD (continued). 12 pp. 8vo. Published June 12, in advance of the Report on the State Museum.—The species described are Brachiopods, Gasteropods and Conchifers, of the Silurian and Devonian.

12. *Coal of Lota.*—Prof. Agassiz states in his letter (see p. 134) that the coal of Lota, and of other localities in the vicinity, north and south, is unquestionably Cretaceous. It is covered with beds containing *Baculites*, many specimens of which he has collected.

13. *On the Rate of Growth of Coral Reefs;* by JAMES D. DANA.—Allowing that the Madrepora of the wreck, mentioned on page 126, may grow 3 inches in height a year, and that other Madrepores increase in the same ratio, it is still not easy to deduce from it the rate of increase of the reef. In the first place, the whole Madrepore is growing over the sides of its branches, at the rate, if we may judge from the size of the trunk at base, of a tenth of an inch a year, thus increasing annually the diameter a fifth of an inch a year, which, in a large species, is a very great addition to the three inches per year at the extremities of the branches. Again, the branches of the large Madrepore of the wreck were widely spaced, those of *M. cervicornis* having intervals of from six to eighteen inches or more between the branches.

In fact it is impossible to make any exact estimate of the amount of increase without a knowledge of the weight of the part annually added. This ascertained, it would be easy to calculate how much the added coral would, if ground up, raise the area that is covered by the Madrepora. A rough estimate gives the author an average increase to this surface of a fourth of an inch a year. But this fourth must be much reduced, if we would deduce the rate of growth of the reef; because a large part of the reef-grounds —that is, of the region of soundings receiving the coral débris— is bare of growing corals. This is the case with much the larger portion of all lagoons and channels among reefs, the bottoms of which, as already explained, are often sandy or muddy, and to a great extent so because too deep for living corals; and it is true

* The comparison of the rod of *Rhabdopleura* with that of a graptolite has already been made by Dr. Nicholson ("Manual of Zoology"), though he adopts the more generally accepted view which finds hydrozoal rather than polyzoal affinities in the graptolites.

even of the coral plantations, these including many and large barren areas. These unproductive portions of reef-grounds constitute ordinarily at least two-thirds of the whole; and making this allowance, the estimate of one-fourth of an inch a year would become one-twelfth of an inch.

Again, shells add considerably to the amount of calcareous material, perhaps one-sixth as much as the corals; but against this we may set off the porosity of the coral.

The rate of growth of the *Mæandrina clivosa*, stated on page 125, would make the rate of increase in the reef very much less rapid. The specimen—grown within fourteen years—weighs 24 oz. avoirdupois, and has an average diameter of 7 inches. This gives for the amount of calcareous material—the specific gravity being 2·523 (p. 99)—16·45 cubic inches; which is sufficient to raise a surface seven inches in diameter to a height of 0·428 inch; and consequently the average *yearly* increase would be about 1-33d of an inch. Allowing for two-thirds of the reef-ground being unproductive in corals, the rate of increase for the whole would become 1-100th of an inch. But supposing that shells add one-fourth as much as the corals to the reef material, the rate of increase would become about 1-80th of an inch per year.

The specimen of *Oculina diffusa*, referred to on page 125, weighs 44 ounces, which is five-sixths more than that of the Mæandrina, while the average diameter of the clump is the same. The average annual increase would consequently cover a circular area of 7 inches diameter 1-18th of an inch deep. And making the same allowances as above, the rate for the year for the whole reef-grounds would be 1-44th of an inch. The specimen of Mæandrina mentioned by Major Hunt is not here made the basis of a calculation, because we have not the specimen for examination, and it is not certain that the diameter stated by him was not the horizontal diameter.

These estimates from the *Mæandrina clivosa* and *Oculina diffusa* have this great source of uncertainty, that the growth of the groups may not have been begun in the first year of the fourteen. Further, the corals obtained by Major Hunt near Fort Taylor, Key West, may not have been as favorably situated for growth as those of the outer margin of the reef. Again, we have made no allowance for the carbonate of lime that is supplied by the waters by way of cement, supposing that this must come originally, for the most part, from the reef itself. Besides, we have above supposed all the coral reef-rock to be solid, free from open spaces; and, further, it is not considered that much of it is a coral conglomerate, in which the fragments have their original porosity.

On the other side, we have not allowed for loss of débris from the reef grounds by transportation into the deep seas adjoining, believing the amount to be very small.

Whatever the uncertainties, it is evident that a reef increases its height or extent with extreme slowness. If the rate of upward

progress is even one-sixteenth of an inch a year, it would take for an addition of a single foot to its height one hundred and ninety years, and for *five feet a thousand years.*

It is here to be considered that the thickness of a growing reef could not exceed twenty fathoms (except by the few feet added through beach and wind-drift accumulations), even if existing for hundreds of thousands of years, unless there were at the same time a slowly progressing subsidence; so that if we know the possible rate of increase in a reef, we cannot infer from it the actual rate for any particular reef; for it may have been very much slower than that. Without a subsidence in progress, the reef would increase only its breadth.—*Dana's Corals and Coral Islands*, pp. 250–253.

18. *Revue de Géologie pour les années* 1868 and 1869, par M. DELESSE et M. de LAPPARENT. Vol. viii. 1872. Paris (Dunod, Editeur).—This Review will be found of great value to all interested in the progress of geological science, or in its practical applications in connection with mining, artesian explorations, tunneling, etc. It has now reached its *eighth* volume.

19. *Memoirs of the Geological Survey of India.*—Vol. VII, Part 1, contains papers on the Vindhyan Series in the Northwestern and Central Provinces, by F. R. Mallet; Mineral Statistics of India, Coal, by Thomas Oldham; Geology of the Shillong Plateau, by H. B. Medlicott; Part 2, the papers on the Kurhurban and Deoghur Coal-fields, by T. H. Hughes; and Part 3, on the Aden Water Supply, by F. R. Mallet, and on the Karanfura Coal-field, by T. H. Hughes.—The paleontological part, issued in 1871, in 4to, Vol. III, contains as Ser. VI, the Pelecypoda, with a review of all known genera of this class, fossil and recent, by F. Stoliczka, illustrated by numerous plates; and Ser. VII, Kutch Fossils, some Tertiary Crabs, by F. Stoliczka, also illustrated in excellent style.

20. *Geological Survey of Canada*, ALFRED C. SELWYN, F.G.S., Director. *Report of Progress for* 1870–71, 352 pp., 8vo. 1872.—This volume contains Reports, by the Director of the Survey, on the progress of the Survey and on the Gold Fields of Quebec and Nova Scotia; by Messrs. L. W. BAILEY and G. F. MATTHEW on Southern New Brunswick; by Mr. ROBB on Northwestern New Brunswick; by Mr. RICHARDSON on the country north of Lake St. John; by Mr. VENNOR on Frontenac, Leeds and Lanark Cos., Ontario; by Mr. BROOME on Phosphate of Lime and Mica; by Mr. BELL on the region north of Lake Superior. The most elaborate report is that of Messrs. Bailey and Matthew. Their report gives a full account of the geology of the region up to the present time, and of the progress of discovery with reference to it, taking up, in succession, the Laurentian areas and rocks, the Huronian or those regarded as probably of this system, the Primordial under the name of the St. John Group. the Upper Silurian, the Devonian, the Lower Carboniferous, the Carboniferous or Coal Measures, and the Triassic or New Red Sandstone. The geology

of New Brunswick was well posted up by Dr. Dawson, in 1868, in the second edition of his excellent Acadian Geology, and illustrated by a geological map. The authors give a more detailed account of some parts of the subject, together with the results of their recent explorations.

The St. John Group, or Primordial beds, the most interesting of all the formations, first recognized as distinct from the adjoining beds by Mr. Matthew, was first proved to be Primordial by Prof. C. F. Hartt, his discoveries with regard to the fossils, added to those previously obtained, enabling him to announce this conclusion with full confidence, the species of *Lingula*, *Paradoxides*, *Agnostus*, *Conocephalites*, *Obolellæ*, &c., placing it beyond doubt. The formation consists mainly of shales and is stated to be a little over 2000 feet in thickness. It occurs in Southern New Brunswick in the depression extending from the city of St. John by way of Loch Lomond lakes to Hammond river, and in the valley of the Kennebecasis, and St. John rivers, in St. John and Northern Kings Counties, and perhaps also in the Nerepis valley and at some other points. The strata of these regions are particularly described in the report, to which the reader is referred for special information on this and other points in Southern New Brunswick Geology.

21. *Stirlingite*, *Rœpperite*.—Kenngott, in the February number of the Jahrbuch für Mineralogie, has applied to the chrysolite containing zinc, described by Rœpper in this Journal, II, l, 35, the name *Stirlingite*, and to the *manganesian dolomite*, of the same author and page, the name *Rœpperite*. The former is named Rœpperite by Prof. Brush in the supplement to Dana's Mineralogy, issued a month later in March last. As the silicate is more deserving of a distinct name, it is to be regretted that Rœpper's name cannot be affixed to it.

The Jahrbuch für Mineralogie, Geologie und Palæontologie, of Leonhard and Geinitz (formerly Leonhard and Bronn), published at Stuttgart, is the only journal in which mineralogists will find all the latest mineralogical news. It is an excellent journal also in its other departments, geology and paleontology.

22. *Oligoclase from Wilmington, Delaware*.—N. Teclu gives for the composition of this oligoclase,

Si 64·75, alumina 23·56, lime 2·84, soda 9·04, potash 1·11=101·30.

The mineral is described as remarkable for having cleavage parallel to both prismatic faces.

23. *Cryptomorphite in Nevada*.—Professor Davidson mentions the occurrence of this borate in Nevada in nodules from four or six inches to as many feet. A specimen had the appearance of French prepared chalk. It occurs in extensive deposits, but the locality the discoverer declined to disclose. Dr. Blake had found it to be a form of borate of lime.—*Proc. Cal. Acad. Sci.*, iv, 195.

24. *Zeunerite* of A. Weisbach, an *arsenate* of uranium and copper, related to uranite in luster, grass-green color, tetragonal

crystallization and easy basal cleavage. G. = 3·2. Composition according to Winkler,

Ās 15·1, Ē 55·6, Fe 5·2, Ċu 8·7, Ċa 1·2, Ḣ 14·5=100·3.

From the analysis is deduced the oxygen ratio for the

Ċu, Ē, Ās, Ḣ, 3 : 18 : 10 : 24.

Jahrb. Min., Feb., 1872, 207.

25. *On a Transparent Garnet from Jordansmühl in Silesia;* by Mr. Websky of Breslau.—This garnet is colorless and has G.= 3·609. The form is the dodecahedron, but with a very obtuse tetrahexahedron $i\text{-}\frac{6}{5}$. It afforded Websky on analysis,

Si 37·88, Al 21·13, Fe 4·19, Mn 0·45, Ni 0·28, Mg 2·88, Ċa 31·28, Ḣ 1·08=99.17;

whence it is essentially an alumina-lime garnet.

26. *On the composition of the vapors or gas escaping in the Phlegræan Fields and other places near Vesuvius;* by Mr. Gorceix.—At the great Solfatara, the gas of the 20th of July consisted of sulphuretted hydrogen 7·0, carbonic acid 88·8, oxygen 0·7, nitrogen 4·5. On the 24th, HS 5·0, CO^2 80·0, O 2·7, N 12·3, the temperature of the gas was 110° to 120°C. On the 25th the gas afforded HS 10·0, CO^2 73·3, O 2·0, N 13·7.

At the Grotto di Zolfo the gas from the entrance consisted of HS 4·7, CO^2 88·2, O 0·7, N with combined gas 6·4; and that from the interior gave for the same ingredients the numbers 5·7, 87·8, 0·7, 5·8. The gas from the baths at Lake Agnano, taken on the 24th of July, afforded in two analyses, CO^2 83·3, 86·9, O 4·1, 2·0, N 12·6, 11·1, with a trace of HS in the second. In other portions there was less of carbonic acid and more of atmospheric acid.

At Torre del Greco gas escaping from fissures in the lavas of the recent eruption afforded HS 20·0, CO^2 91·5, O 0·7, N with combined gas 7·8. [These numbers do not foot up 100, and either that for HS or that for CO must be 20 or less in error]. At Chiatamone the gas consisted of CO^2 82·1, O 1·7, N 16·2.—*Ann. Ch. Phys.*, IV, xxv, 559.

27. *Note on Rhinosaurus;* by O. C. Marsh.—In the June number of this Journal (p. 461), I proposed the name *Rhinosaurus* for a new genus of Mosasauroid reptiles. As this name proves to be preöccupied, it may be replaced by *Tylosaurus*. The name *Rhamphosaurus*, since suggested by Prof. Cope, cannot be retained, as it was given to a genus of lizards in 1843 by Fitzinger.

III. Zoology and Botany.

1. *Note on Intelligence in Monkeys;* by Prof. Cope.—I have two species of *Cebus* in my study, *C. capucinus*, and a half-grown *C. apella*. The former displays the usual traits of monkey ingenuity. He is an admirable catcher, seldom missing anything, from a large brush to a grain, using two hands or one. His cage door is fastened by two hooks, and these are kept in their places by nails driven in behind them. He generally finds means sooner or later to draw out the nails, unhook the hooks and get free. He then occupies himself in breaking up various objects and examin-

ing their interior appearances, no doubt in search of food. To prevent his escape I fastened him by a leather strap to the slats of the cage, but he soon untied the knot, and then relieved himself of the strap by cutting and drawing out the threads which held the flap for the buckle. He then used the strap in a novel way. He was accustomed to catch his food (bread, potatoes, fruit, etc.), with his hands, when thrown to him. Sometimes the pieces fell short three or four feet. One day he seized his strap and began to throw it at the food, retaining his hold of one end. He took pretty correct aim, and finally drew the pieces to within reach of his hand. This performance he constantly repeats, hooking and pulling the articles to him in turns and loops of the strap. Sometimes he loses his hold of the strap. If the poker is handed him, he uses that with some skill, for the recovery of the strap. When this is drawn in, he secures his food as before. Here is an act of intelligence which must have been originated by some monkey, since no lower or ancestral type of Mammals possess the hands necessary for its accomplishment. Whether originated by Jack, or by some ancestor of the forest who used vines for the same purpose, cannot be readily ascertained.

After a punishment, the animal would only exert himself in this way when not watched; as soon as an eye was directed to him, he would cease. In this he displayed distrust. He also usually exhibited the disposition to accumulate to be quite superior to hunger. Thus he always appropriated all the food within reach before beginning to eat. When different pieces were offered to him, he transferred the first to his hind feet to make room for more; then filled his mouth and hands, and concealed portions behind him. With a large piece in his hands, he would pick the hand of his master clean before using his own, which he was sure of.—*Proc. Acad. Nat. Sci.*, April, 1872, p. 40.

2. *Curious Habit of a Snake;* by Mr. Cope.—Mr. Cope made the following remarks:—I had for some time a specimen of *Cyclophis æstivus*, received from Fort Macon, N. C., through the kindness of Dr. Yarrow, living in a wardian case. The slender form of this snake, and its beautiful green and yellow colors, have led to the opinion that it is of arboreal or bush-loving habits. It never exhibited such in confinement, however, and instead of climbing over the Caladia, ferns, etc., lived mostly under ground. It had a curious habit of projecting its head and two or three inches of its body above the ground, and holding them for hours rigidly in a fixed attitude. In this position it resembled very closely a sprout or shoot of some green succulent plant, and might readily be mistaken for such by small animals.—*Ibid.*

3. *Diatoms in Hot Springs.*—Dr. Blake has collected diatoms at a hot spring in Pueblo valley, Humboldt Co., Nevada, the temperature of which was 163° F. More than fifty different species were recognized by him; and they were found to be mostly identical with the species found in beds of infusorial earth in Utah and described by Ehrenberg, showing that the latter must have

been accumulated in a hot lake, of about the same temperature. No other living species were found in the hot waters, excepting red algæ. The deposit was a large one, and in it there were concretions of silica. On making a thin section of one of these concretions, a pair of legs of a coleopterous insect was visible in the quartz; the greater part of the concretion was made up of petrified algæ.

In one of the hot springs at the California geysers, having a temperature of 198° F., he found two kinds of Conferva, one capillary, resembling *Hydrocrocis Bischoffii*, but larger, the other a filament, with globular enlargements at intervals. In another spring, the temperature 174° F., many Oscillariæ were found, which by the interlacement of their delicate fibers formed a semi-gelatinous mass; and also two diatoms. In the water of the creek of Geyser Cañon, 112° F., the algæ formed layers sometimes 3 inches thick covering the bottom of the pools, and the same diatoms were found as in the 174° spring. The waters are acidulated by the presence of free sulphuric acid, and Dr. Blake suggests that this may account for the rarity of diatoms.—*Proc. Cal. Acad. Sci.*, iv, 183, 189, 193, 197.

4. *Life in the Mammoth Cave. The Mammoth Cave and its inhabitants, or descriptions of the Fishes, Insects and Crustaceans found in the Cave; with figures of the various species and an account of allied forms, comprising notes upon their structure, developments and habits, with remarks upon subterranean life in general;* by A. S. PACKARD, Jr., and F. W. PUTNAM, Editors of the American Naturalist. 62 pp. 8vo. Salem, 1872.—This excellent and most interesting memoir first appeared in the American Naturalist for December, 1871, and January, 1872. It treats of one of the most curious departments of natural history,—the *subterranean* life of the continent and world, and is illustrated by two plates and many wood-cuts. The work is got up in fine style, and is issued by the Naturalist's Agency at Salem.

5. *Reproduction of Sponges.*—Mr. H. J. Carter has an important article on this subject in the Ann. Mag. Nat. Hist. for June, and also in the same number he describes two new sponges from the Antarctic Sea, and a new species of Tethya from Shetland.

6. *Robert Brown's first Botanical Paper*, "*The Botanical History of Angus*," which was read before the Edinburgh Natural History Society on the 26th of January, 1792, and was found in its MS. records last summer by Dr. Carruthers, has been printed in the Journal of Botany, British and Foreign, for November last. It mainly consists of notes upon the rarer plants which the writer collected in Angusshire in the summer of 1791. He was then in his 18th year. The most interesting article contained in it is that upon *Drosera rotundifolia* which is as follows:

"*Drosera rotundifolia* is a plant not unfrequently to be met with on marshy ground. According to Mr. Lightfoot, the *longifolia* is equally common in Scotland, but this is far from being really the case. It has of late been asserted that the leaves of

the *Drosera* have the power, when a small body is applied to their upper surface, of contracting and enclosing the substance so applied, by this means in many cases proving a trap to those insects which happen to light upon them. The examination of this fact is certainly worth the attention of the naturalist. In the second edition of Withering's 'Botanical Arrangement,' it is alleged that this phenomenon was observed immediately to follow the application of the substance. But it appears from works of a late German author, that several hours generally elapsed before the leaf was completely folded together. The same author observes that when an insect is placed upon a leaf it naturally endeavors to escape, but is prevented by the viscid juice which is secreted by the long hairs on its upper surface. In a short time these hairs begin to be bent inward, and gradually clasp the insect, which about this time is found dead, not so much in all probability from the pressure of the hairs, which cannot be great, but rather from the nature of the fluid which they exude. After the hairs have thus enclosed the animal the leaf itself begins to contract, and by very slow degrees at last covers its prey. Although I by no means pretend to deny the fact alleged by Dr. Withering, which was related from the actual experiment, yet I am more inclined to give more credit to the German author's experiments. In a few trials which I made myself no contraction followed after a very considerable time, nor did I at all observe it. But as it must be owned that these were made with a pin instead of an insect, I cannot pretend to contradict the fact, but rather to blame the mode in which the trials were made. For it is well known to every one who has seen this plant in the growing state that many of its leaves are generally folded, and if these are opened there is always found some substance enclosed. If, therefore, the *Drosera* is endowed with such a power (and there is the strongest reason to believe it is), we shall have some difficulty in accounting for it on principles merely mechanical."

The "German author" referred to was probably Roth. In our November number an observation on the folding of the leaf of *D. longifolia* by Mrs. Treat of New Jersey is recorded, and was thought to be wholly new. A. G.

7. Prantl's memoir upon *Inuline*, an inaugural dissertation, we believe, crowned by Munich University, and printed in Bot. Zeit., 1870, No. 39, is thus noticed:—

"The results obtained by the author of this memoir are in all essential features in accordance with what MM. Nägeli and Sachs have said of inuline. M. Prantl describes this substance as a hydrate of carbon, which differs from starch, cellulose, and lichenine, in never taking on an organic form. Its fixity sufficiently differentiates it from dextrine. It seems to approach most nearly to cane-sugar.

"Inuline is constantly found in plants in the form of a solution of 1 part of inuline to 7 of water. As in artificial solutions, 0·01 gram of inuline saturates 100 cub. centims. of water, we may sup-

pose that when dissolving in the plant it undergoes transformation. It never appears except in subterranean organs.

"This substance is pretty frequently produced in plants of different families, but especially in the Compositæ. The *Dahlia* and certain *Helianthi* contain considerable quantities of it.

"From a physiological point of view, inuline plays exactly the part of one of those nutritive principles which are put in reserve, such as starch, sugar, oils, &c. As we have just said, it exists exclusively in subterranean organs, tubers, or rhizomes. At the moment of growth it is transformed into cane sugar toward the collar of the root, then mounts into the stem in the form of starch, and thus passes to the buds. Subsequently, the starch produced in the leaves descends along the stem in the form of starch itself or of sugar, and it is only on its arrival in the root that it takes on the form of inuline."

The concluding portion of Micheli's revision is devoted to fecundation in phænogamous plants, and the part which insects play in it. Upon this topic the readers of this Journal have been kept in a general way informed. A. G.

8. The *Erysiphei* of the United States. 26 species are enumerated in Seemann's (now Trimen and Baker's) Journal of Botany for Jan., 1872, in an article by Mr. Cooke and C. H. Peck of Albany; and half that number of Schweinitz's species of *Erysiphe*, and one or two of Berkeley and Curtis, are appended as Species inquirendæ. A supplement appears in the June number. A. G.

9. *Kan-sun* is the name of a Chinese culinary vegetable, known under the English name of cane-shoots, upon which Dr. Hance has an article in the May number of the Journal of Botany. He commends it as one of the nicest vegetables known, in flavor nearest the American "green corn," but of a peculiar richness and delicacy. He has ascertained that these cane-shoots are the solid base of a grass, viz. of *Hydropyrum latifolium* of Grisebach, which is so very nearly allied to our American *H. esculentum*, i. e., to *Zizania aquatica*, that, if not the very same, Dr. Hance thinks it probable our wild rice may afford similar esculent roots,—which may be worth attending to. A. G.

10. *Martius, Flora Brasiliensis*, fasc. 55, contains *Violaceæ*, *Sauvagesiaceæ* (restored to a distinct order, with indications of nearer affinities to *Parnassia* and to *Hypericaceæ* than to *Violaceæ*), *Bixaceæ* (well including *Samydaceæ*), *Cistaceæ*, and *Canellaceæ*, the last two each of a single genus and species, by the editor, Prof. Eichler; *Tropæolaceæ* (which we like to see kept separate from *Geranicæ* proper, but not as an order), *Molluginaceæ*, *Alsinaceæ*, *Silenaceæ*, *Portulaccaceæ*, *Ficoidaceæ*, and *Elatinaceæ* (very small orders in Brazil, but their exposition accompanied by some acute remarks), by the late Dr. Rohrbach, whose early death is much to be regretted. Systematic botanists are few in Germany. A. G.

IV. Astronomy.

1. *On the Temperature of the Surface of the Sun;* by J. Ericsson.—It will be recollected that Messrs. M. E. Vicaire and Sainte-Claire Deville read some papers before the Academy of Sciences at Paris last January, showing that the temperature of the solar surface does not exceed that produced by the combustion of organic substances, their reasoning being based on the law of radiant heat established by the investigations of Dulong and Petit. I have in the meantime instituted a series of experiments on a comparatively large scale, in order to test the correctness of the said law. Accordingly, the dynamic energy developed by the radiation of a mass of fused iron weighing 7,000 pounds, raised by "overheating" in the furnace to a temperature of 3,000° F., has been carefully measured.

Sir Isaac Newton assumed that the quantity of heat lost or gained by a body in a given time is proportional to the difference between its temperature and that of the surrounding medium. Some eminent scientists, however, accepting Dulong's conclusions and formula, assert positively that the stated assumption is incorrect. In so doing they apparently overlook the conditions inseparable from the Newtonian doctrine, namely, that the conducting power of the radiating body should be perfect; that at every instant the temperature pervading the interior mass should be transmitted to the surface.* It needs no demonstration to prove that if the conducting power of a body be so perfect that the temperature of the center is at all times the same as that of the surface; in other words, that the fall of temperature at the center, occasioned by radiation, is as rapid as the fall of temperature at the surface, the rate of cooling of such a body will be very different from that observed by Dulong and Petit. The investigation instituted by those experimentalists has in reality established only the degree of conductivity of the radiators employed, under certain conditions, but by no means their true radiant energy at given temperatures. M. E. Vicaire and Sainte-Claire Deville, therefore, commit a serious mistake in assuming that the *quantity* of heat transmitted by the radiation of incandescent bodies at high temperatures has been determined. It may be observed that the relation between the time of cooling and the *quantity* of heat transmitted by radiation which Dulong and Petit established, also

* The writer has just completed a set of experiments with a spherical radiator, 2·75 in. in diameter, composed of very thin hammered copper, charged with water kept in motion by a wheel applied within the sphere, revolving at a rate of 30 turns per minute, the centrifugal action of which brings the particles of the central portion of the fluid so rapidly in contact with the thin spherical shell, that the apparently absurd condition of perfect conductivity has been practically fulfilled. The result of carefully conducted experiments with this radiator, enclosed in an exhausted vessel kept at a constant temperature, has established that Newton's law relating to radiant heat, up to a differential temperature of 100° Fahr. (beyond which the investigation has not extended), is rigorously correct. The subject will be fully discussed in a future article.

misled Pouillet regarding the temperature of the solar surface, which he computed at 1,461° C., or at most 1,761° C. It will be well to bear in mind that Pouillet had himself ascertained with considerable accuracy the temperature produced by solar radiation on the surface of the earth; and also the retardation suffered during the passage of the rays through the terrestrial atmosphere. He was therefore able to demonstrate that the dynamic energy developed by solar heat amounts to nearly 300,000 thermal units per minute for each square foot of the surface of the sun. Considering the imperfect means employed by Pouillet, his "pyrheliometre," the exactness of his determination of solar energy is remarkable. The truth is, however, that the near approach to exactness was somewhat fortuitous, the eminent physicist having underrated the energy of radiant heat on the surface of the earth, while proportionately over-estimating the retarding influence of the terrestrial atmosphere. The true dynamic energy developed by radiation at the surface of the sun, exclusive of the absorption of the solar atmosphere—no doubt exceedingly small—determined by the solar calorimeter mentioned in a previous article, is 312,500 thermal units per minute upon an area of one square foot. It will be proper to notice that this amount is not a mean result of a number of observations, but the greatest energy developed at any time during observations continued upwards of three years, namely February 28, 1871. It will be proper to add that this result has been withheld from publication until it could be verified by a second observation indicating an equal energy. Fortunately the sky at noon, March 7, 1872, proved to be as clear as on the previous occasion referred to, the indicated energy differing only a few hundred units from that developed February 28, 1871.

Temperature being a true index of molecular and mechanical energy, conclusively established by the exact relation between the degree of heat and the expansive force of permanent gases under constant volume, it is surprising that Pouillet did not perceive that an intensity of 1,461° C. or 1,761° C., could not possibly develop on a single square foot of surface the enormous energy represented by 300,000 thermal units per minute. M. Vicaire, adopting like Pouillet Dulong's formula, states in the paper presented to the French Academy that "an increase of 600° is sufficient to increase the radiation a hundred fold;" and that Pouillet has verified Dulong's law to more than 1,000°. "Supposing," he observes, "that beyond this temperature the law ceases to be true, it cannot be absolutely remote from the truth for the temperatures of from 1,400° to 1,500°, which we deduce by adopting the law." Sainte-Claire Deville concludes his essay on solar temperature thus:—"In accordance with my first estimate I believe that this temperature will not be found far removed from 2,500° to 2,800°, the numbers which result from the experiments of M. Bunsen, and those published long ago by M. Debray and myself." The French *savans* then agree that the temperature of the surface of the sun does not exceed the intensity produced by the combustion of

organic substances, their grounds for this assumption being, as we have seen, Dulong's formula relating to the velocity of cooling at high temperatures. But Dulong and Petit did not carry their investigations practically beyond the temperature of boiling mercury; hence their formula relating to high temperatures is mere theory, the soundness of which we have now been enabled to test most effectually by measuring the radiant power of a mass of fused metal raised to a temperature of 3,000° F., 30 inches in depth, presenting an area of 900 square inches.

Before describing the means which have been employed in measuring its radiant power, let us briefly consider the condition of the fused mass during the experiments. In the first place, the temperature has been sufficiently high to produce an intense white light, luminous rays of great brilliancy being emitted by the radiant surface during the trial; (2) the bulk of the fused mass being adequate, the intensity of radiation has been sustained without appreciable diminution during the time required for observation; (3) the temperature being higher than that which the French investigations assign to the surface of the sun, while the bulk, as stated, is sufficient to maintain the temperature of the fused mass, it may be reasonably asked, why an area of one square foot of our experimental radiator should not emit as much heat in a given time as an equal area on the solar surface, if its temperature be that assumed by Pouillet? It may be positively asserted, moreover, that an increase of the dimensions of our radiator to any extent, laterally or vertically, could not augment the intensity or the dynamic energy developed by a given area. Again, Dulong's formula, as applied by scientists, shows that the emissive power of a *metallic* radiator, raised to a temperature of 3,000°, reaches the enormous solar emission computed by Pouillet.

[The description and drawings of the calorimeter used with the account of the method of experimenting are here omitted.—Eds.]

Having thus ascertained practically the amount of dynamic energy developed by the radiation of a metallic body raised to the high temperature of 3,000°, we have only to show in a similar manner the amount of energy developed by a metallic radiator of a low temperature, to be enabled to demonstrate the correctness or fallacy of Dulong's formula. Numerous experiments have been made for this purpose with apparatus of different forms, the results having proved substantially alike. The device most readily described consists of a spherical vessel charged with water, suspended within an exhausted spherical enclosure kept at a constant temperature. Repeated trials show that, when the differential temperature is 65°, the enclosure being maintained at 60°, while the sphere is 125°, the dynamic energy transmitted to the enclosure by a sphere the convex area of which is one square foot amounts to 5·22 thermal units per minute. The accuracy of this determination is confirmed by the fact that, during the summer solstice at noon, when the sun's differential radiant intensity is 65°, the solar

calorimeter indicates a dynamic energy of 5·12 units per minute on one square foot of surface.

Our practical investigations, then, show that a differential temperature of 3,000° developes by radiation a dynamic energy of 1,013 thermal units per minute upon an area of one square foot; and that a differential temperature of 65° develops 5·22 units per minute upon an equal area. The ratio of radiant energy at the first mentioned intensity will therefore amount to $\frac{1013}{3000}$=0·337 units for each degree of differential temperature; while for the low intensity it will be $\frac{5·22}{66}$=0·080 unit for each degree of differential temperature. Consequently, the ratio of the radiating energy will be $\frac{0·337}{0·080}$=4·21 times greater at 3,000° than at 65°. Now, M. Vicaire, on the authority of Dulong, states that the ratio will be a hundred fold greater for an increase of only 600°. According to Newton's theory, based on dynamic laws, the proportion between the differential temperature and the radiant energy of bodies is constant; while Dulong and Petit, basing their conclusions upon an erroneous estimate of the time of cooling, assert that the ratio of energy increases several thousand times when the temperature is increased from 65° to 3,000°. Newton, then, as our experiments prove, is incomparably nearer the truth than the French experimenters; and possibly future research will prove that his law, when properly applied, will be found absolutely correct. It should be mentioned that the results of our experiments with the fused metal, compared with the results of other experiments with solid metals at various temperatures, show that the emissive power of cast iron is relatively greater in a state of fusion than when solid, or merely incandescent. This observed increase of emissive power, now being thoroughly investigated, will no doubt account for the deviation from the Newtonian law indicated by the preceding comparison, which, let us recollect, is based upon the difference of radiant energy of fused metal at 3,000°, and solid metal at 65°. Considering this extreme range of temperature, and the totally different conditions of the radiators, the observed discrepancy is not too great to admit of satisfactory explanation.

The fallacy of Dulong's formula relating to high temperatures having been conclusively shown, it will not be necessary to examine the calculations of Messrs. M. E. Vicaire and Sainte-Claire Deville, presented to the Academy of Sciences at Paris. Besides, the question of solar temperature cannot be properly investigated without considering the leading points connected with the propagation of radiant heat through space—a subject of too wide a range to be discussed in this article. It should, however, be mentioned that the result of the measurement of solar intensity March 7, 1872, before referred to, proves the correctness of our previous demonstrations, showing that the temperature of the surface of the sun is at least 4,036,000° F.—*Nature, April* 25.

2. *Aurora of February* 4.—Prof. GABB writes to one of the editors, from San Domingo, under date of June 18th, that about Feb. 4, and with little doubt on that evening (since it is not probable that there was another there), "We were sitting on the porch, facing the north, when my mother called our attention to a dull red glow on the northern sky extending perhaps 30° high, considerably above the pole star; you know we are in 18° N. At first my impression was that it was the reflection of fires on clouds —some prairie on fire—but there were no clouds; all of the stars shone brightly through it. I cannot say how long it lasted. I saw it occasionally for two hours. We first noticed it between 8 and 9 P. M.—See, for observations in Australia, page 158.

3. *Edinburgh Astronomical Observations.* Vol. XIII, 1860–1870.—A very large and thick volume, containing besides Astronomical Observations of the Royal Observatory of Edinburgh, with the Transit and Mural Circle, and Star Catalogues made during each of the years of the decade 1860 to 1870, occupying 761 pages; also Meteorological tables for Scotland and Scottish towns, accounts of storms, and a long memoir on the Great Pyramid in Egypt, giving measurements of all the Pyramids, and special detailed measurements of the great Pyramid of Jeezeh. The volume closes with the several annual Reports to the Board of Visitors, and a paper on Auroral and other Faint-Light Spectroscopy in 1871. It is illustrated by 56 plates, 37 of which relate to the Pyramids, and two to Faint-Light Spectroscopy.

4. *Astronomical and Meteorological Observations made at the U. S. Naval Observatory during the year* 1869, Commodore B. F. SANDS, U. S. N., Superintendent. Published by authority of the Hon. Secretary of the Navy. xliv and 396 pages 4to, with an Appendix of 132, xv and 332 pages. Washington. 1872.—Nearly 400 pages of this Report are devoted to the results of the observations of 1869. Appendix I. contains the Reports on the Solar Eclipse of the year, by Prof. Newcomb, U. S. N., Prof. Asaph Hall, U. S. N., Prof. Wm. Harkness, U. S. N., and Prof. J. R. Eastman, U. S. N., illustrated by several cuts and two plates. Appendix II, running to 332 pages, is devoted to tables pertaining to the catalogue of stars in progress in the observatories with the mural circle. The volume is a record of a great amount of excellent work.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Height of Mt. Rainier and Mt. Baker.*—Officers of the Coast Survey, Prof. Davidson and Mr. Lawson, have determined the height of Mt. Rainier to be 14,444 feet, or 4 feet greater than that of Mt. Shasta. It is situated in latitude 46° 51′ 09″ and longitude 121° 45′ 28″. Prof. Davidson says that there are glaciers on Mt. Rainier. Mt. Baker had previously been found to be 10,760 feet high.—*Proc. Cal. Acad. Sci.*, iv, 1871, 157.

2. *Glaciers on the Mountains of the Pacific Coast.*—Prof. Davidson observes, with respect to the first notice of glaciers on

the Pacific slope of N. America, that Lieutenant (now General) Aug. V. Kautz, U. S. A., attempted to ascend Mt. Rainier in 1856 or 1857, but found his way barred by great glaciers; and that Mr. Coleman, of the Alpine Club, ascended Mt. Baker in 1869, and published that year a description of the glaciers, in Harper's Magazine with illustrations.—*Proc. Cal. Acad. Sci.*, iv, 161, 1871.

3. *Academy of Natural Sciences of Philadelphia.*—With January of 1871, this academy commenced the third series of the Proceedings, *illustrated.* Part III. of 1871 has thirteen excellent plates, part of them colored. One of them contains colored figures of two snakes, *Nothopsis rugosus* Cope, and *Bothrops atrox;* and the rest represent various species of fishes. The charge per year for the illustrated Proceedings is $5.00 to members, and $6.25 to the public. The 2d series of the Proceedings, consisting of 14 volumes, commenced in 1857, and is sold for $42 to members, and $3.75 per volume to the public. The first series of 8 volumes was begun in 1841; price $24 to members, and $30 to the public.

The first series of the Journal of the Academy consists of eight octavo volumes. The new series, in quarto, was commenced in 1847, and seven volumes have been published. The price per volume is $10.

4. *Memorie della Società dei Spettroscopisti Italiani;* edited by Prof. P. Tacchini.—At the close of last year there were no less than five spectroscopes in Italy in the hands of assiduous and skillful observers; two at Rome used by Secchi and Respighi; one at Padua by Lorenzoni; one at Naples under the care of Dr. Gasparis, and one at Palermo by Tacchini. At least one more has since been added, that is at Florence, by Donati

An Italian Society has been formed for the prosecution of spectroscopic observations and their publication, and four numbers of their *Memoirs*, corresponding to the first four months of 1872, have been received. They are published, with extended illustrations, at Palermo, under the supervision of Prof. Tacchini. The following is a list of the articles of the four numbers received:

January. 1. New Society of Italian Spectroscopists; account by P. Tacchini. 2. Spectroscopic observations upon the solar limit; by G. Lorenzoni. 3. Tables for converting the angle of position of a point on the sun's limit into corresponding heliographic polar distances; by G. Lorenzoni. 4. New Micrometer for the protuberances; by A. Secchi. (Two plates.)

February. Solar protuberances simultaneously observed at Palermo, Rome, and Padua in July and August, 1871; reported by P. Tacchini. (Two plates.)

March. 1. Observations on the solar protuberances and their distribution; by A. Secchi. 2. Spectroscopic pictures of sun's limb, made at Palermo, Rome, and Padua, on the 11th and 12th of December, 1871, by Tacchini, Secchi, and Lorenzoni. (One plate).

April. 1. On the deviation of the lines of the spectrum due to change of temperature of the prism; by P. Blaserna. 2. Spectroscopic pictures of the sun's limb, made at Palermo and Rome in

August and November, 1871; by P. Tacchini. 3. Spectroscopic observations of solar spots made at Florence; a letter from Prof. Donati to P. Tacchini. (One plate.)

5. *Monthly Record of Results of Observations in Meteorology, Terrestrial Magnetism, etc.* Taken at the Melbourne Observatory, during January, 1872; together with abstracts from meteorological observations obtained at various localities in Victoria. Under the superintendence of R. L. J. Ellery, Government Astronomer. 14 pp. 8vo. Published by authority of her Majesty's government in Victoria.—Besides various meteorological tables, this Report contains the following on the

Aurora of February, 1872.—An Aurora Australis was visible shortly after midnight on the 5th until the early morning, coincident with which great magnetic disturbances took place, particularly of the horizontal force, and to a less extent the declination. They commenced at midnight. The maximum disturbance occurred shortly before 3 A. M., when the minimum easterly declination was reached, and continued until 5.15 A. M., when the maximum declination occurred, the extreme range amounting to 1° 18′ of arc; the disturbances then became less violent, and by noon consisted of a succession of slow regular oscillations, gradually getting smaller until toward midnight of the 6th, they ceased. The extreme range in the horizontal force occurred between 1^h and 3^h A. M., amounting to 0·2940 of the absolute British unit, the maximum occurring at 1^h A. M., and the minimum at 3^h P. M. The motion of the needle was at times exceedingly rapid, moving once within a few minutes through 0·1737 of the absolute unit.

6. *Hayden's Exploring and Surveying Expedition.*—This expedition, sent out under the authority of the Secretary of the Interior, is again in the Rocky Mountains, continuing its surveys. Prof. F. H. Bradley has joined the expedition as geologist. Congress made an appropriation at its last session of $75,000 for the expenses of the current year.

Professor Bradley says in his letter cited from on page 133, dated July 7th: "Delay has been rather tedious, even in the midst of work; but the rivers have been so full that we could not profitably have gone into the higher mountains earlier, if we had been ready. Dr. Hayden, with his division of the party, is at Fort Ellis, nearly ready to start in. We expect to meet him in the Firehole Basin, in the latter part of August."

7. *Memoirs of the Peabody Academy of Sciences.* Vol. i, No. iii.—*Embryological Studies on Hexapodous Insects;* by ALPHEUS S. PACKARD, Jr. 18 pp., with three beautiful plates.—The species, the development of which Mr. Packard here describes, are *Nematus ventricosus*, *Pulex canis*, *Alletabus Rhois*, *Telephorus Fraxini*, *Chrysomela polygoni*, *Mysia* 13-*punctata* and *Chrysopa oculata*.

8. *Petroleum in San Domingo.*—Mr. A. P. MARVINE writes to one of the editors, in a letter dated Houghton, Michigan, June 16, as follows: "*Apropos* to Mr. Gabb's article 'On the occurrence of Petroleum in the Island of Santo Domingo,' in the June number

of this Journal, I would like to call your attention to some very similar remarks on the same subject in the 'Report of the Commission of Inquiry to Santo Domingo' (pp. 109–110), which was issued by Government about a year ago.

"When at the spot in question I gathered about a quart of the oil from one of the pits, and a small bottle of the gas which bubbles from the well, and still have them well sealed."

9. *American Association.*—The next meeting of the Association will be held at Dubuque, Iowa, instead of San Francisco, commencing August 21st. Dr. J. LAWRENCE SMITH is president for the year.

OBITUARY.

Dr. WILLIAM STIMPSON.—The news of the death of Dr. William Stimpson, late Secretary of the Academy of Sciences of Chicago, will be received with great regret by his numerous friends and scientific associates. Dr. Stimpson's health has been quite precarious for several years past, making it necessary for him to proceed every winter to the warmer climate of Florida, and the past winter was spent by him in the same region. He was engaged in the earlier part of the season on board the United States Coast Survey steamer *Bache*, in superintending a series of dredgings between Cape San Antonio, Cuba, and the coast of Yucatan; and thence proceeding to Key West, he attempted to prosecute some deep-sea work in the waters between Florida and Cuba. This, however, was prevented by increasing ill health. Returning not long since to the residence of his father-in-law, near Baltimore, he became gradually worse, and died there on the 26th of May.

This is not the occasion for presenting a full account of Dr. Stimpson's life; but of his merits as a naturalist it is proper to say that he occupied the very first rank among American zoölogists, especially in the department of marine invertebrates. For a time a pupil of Professor Agassiz at Cambridge, he made his first mark as a scientific author in 1851, in a work on the shells of New England, which was soon followed by a paper upon the marine invertebrates of Grand Manan, published by the Smithsonian Institution in 1853, and which is still a standard work on the zoölogy of the mouth of the Bay of Fundy.

Shortly afterward he was appointed zoölogist to the North Pacific exploring expedition, first under Captain Cadwallader Ringgold, and subsequently under Captain John Rodgers. He was occupied in this service several years, and then returned and spent a number of years at Washington in the quiet prosecution of his investigations and the publication of their results.

When the late Mr. Robert Kennicott went to Alaska, in 1865, in the service of the Russian telegraph expedition, Dr. Stimpson moved to Chicago to take charge of the general affairs of the Chicago Academy of Sciences, and maintained that connection until his death. During that interval he visited Florida on several occasions, and always obtained numerous interesting collections for the Academy.

As a scientific investigator Dr. Stimpson occupied a very high rank for the thoroughness of his researches, and the clearness and accuracy of his descriptions, in these respects leaving nothing to be desired. No one, with the exception, perhaps, of Prof. Dana, has described so many new species of marine animals as he.

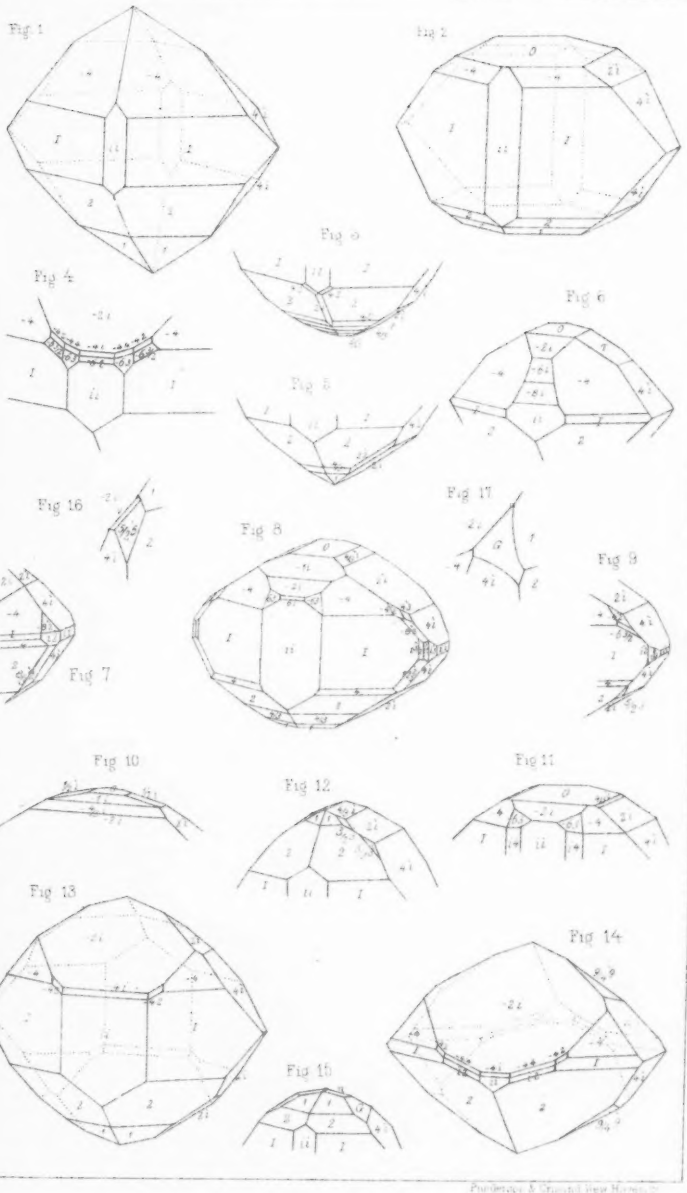
The detailed accounts of his new species, forming a large number of valuable zoölogical monographs, with large numbers of illustrations, and nearly ready for publication, were unfortunately all destroyed by the Chicago fire, together with most of the types of this species—a calamity which of course affected him severely, and in all probability influenced the state of his health. Among these works were synopses of the Mollusca of the east coast of North America, and of the Crustacea of both coasts, to be published by the Smithsonian Institution.—X., in *Harper's Weekly*.

The meeting of the Chicago Academy of June 11th was devoted to addresses in memory of Dr. Stimpson by the President and other members. We cite the following paragraph from the remarks of Mr. E. W. Blatchford:

"I am reminded, Mr. President, that this is the second time in the brief history of our Academy that we have been called upon to mourn the loss of a secretary. They were both men of marked characters, of marked differences. In the scientific world they were typical men—the one of our young West, the other of the maturer East—the one of the undeveloped fields afforded by our lakes, with the territory adjacent, and stretching west and north to the Pacific and Arctic coasts: the other of the more thoroughly investigated Atlantic slope, and foreign field of scientific research. Differing, however, in early opportunities and training, in subsequent associations, and in the fields of their investigations, Kennicott and Stimpson were yet *one*; one in high aims, one in enthusiastic devotion, one in self-forgetfulness, one in persevering and successful labor. And in the faithful performance of duty was each called away. To the one the summons came in the Arctic regions, upon the banks of the Youkan: to the other in the tropics, upon the banks of that wider, deeper stream, the study of whose mysteries had lured him on in spite of pain and weakness. Already are the foundations laid and the walls rising of our new Academy; but the future growth of our collections, and increasing influence, will ever be associated in our minds with our obligations to these men, whose lives have been consecrated to laying here the foundations of scientific truth."

Mr. Robert Swift, of Philadelphia, died on the 5th of May, in the seventy-seventh year of his age. Mr. Swift from 1852 labored much in West Indian Conchology, and in 1863 published his "Researches of the Virgin Islands." He also contributed, through collections made at his expense on St. Thomas and Porto Rico, to the ornithological collections of the Smithsonian Institution, on which a report was made by Dr. Bryant of Boston.

George Robert Gray, an eminent British ornithologist, and Assistant Keeper of Zoology in the British Museum, died on the 6th of May last. He was born in July, 1808.



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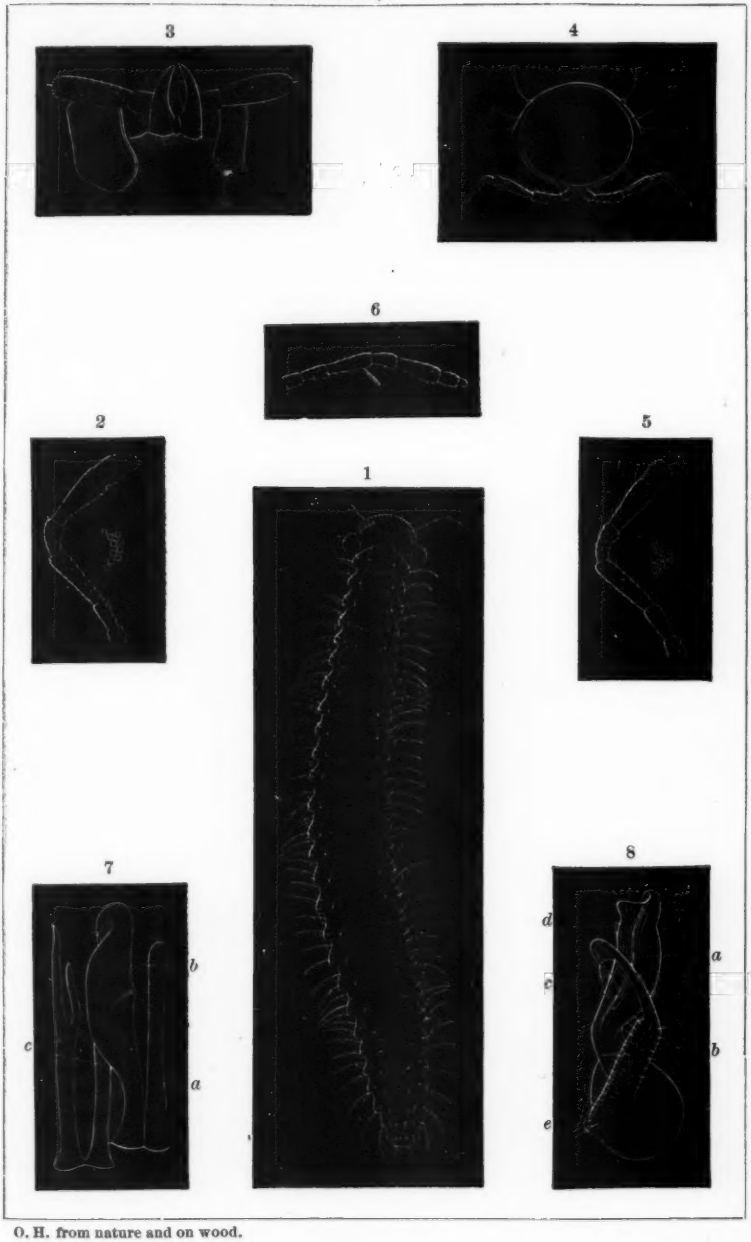

O. H. from nature and on wood.